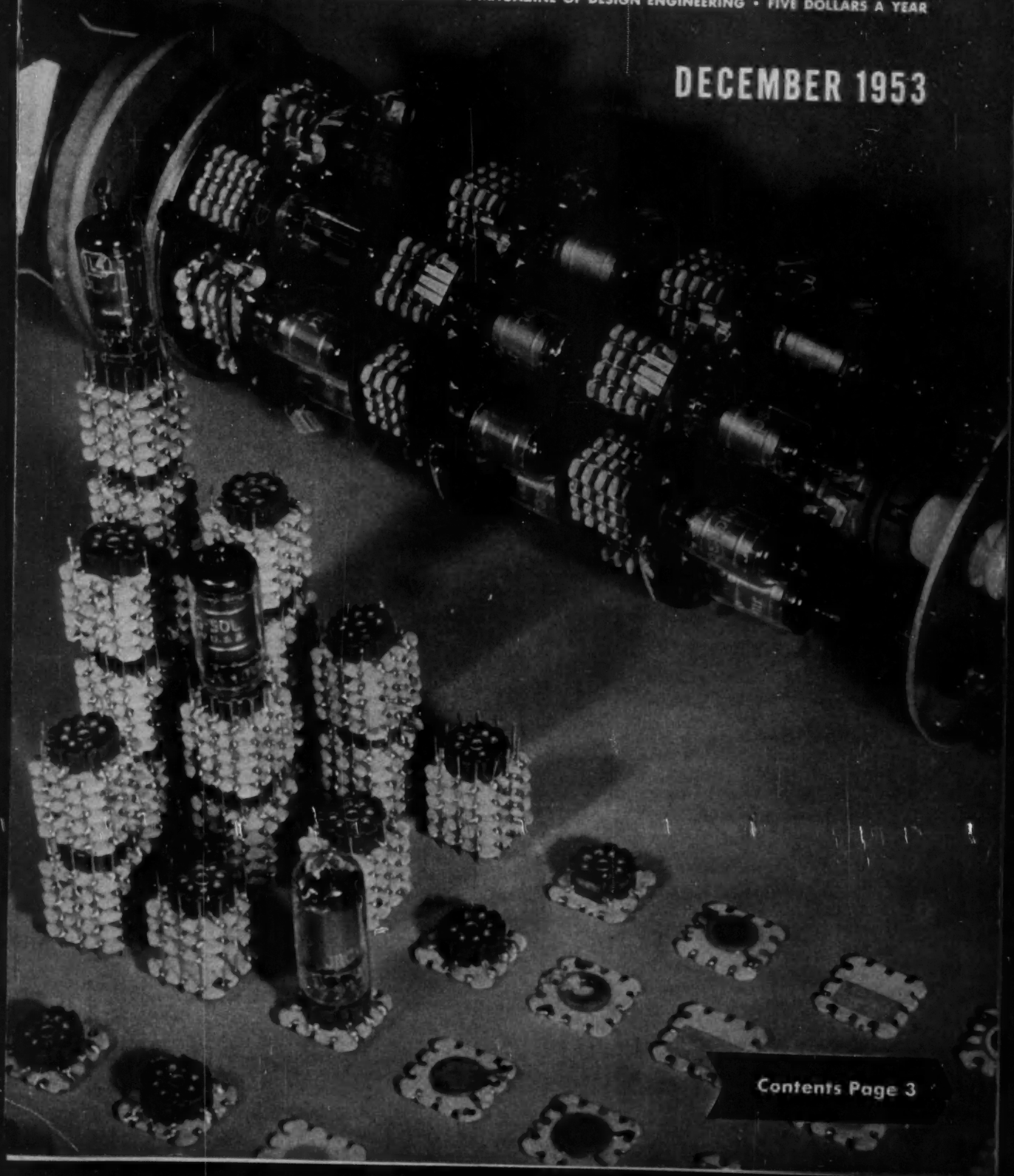
Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING • FIVE DOLLARS A YEAR

DECEMBER 1953



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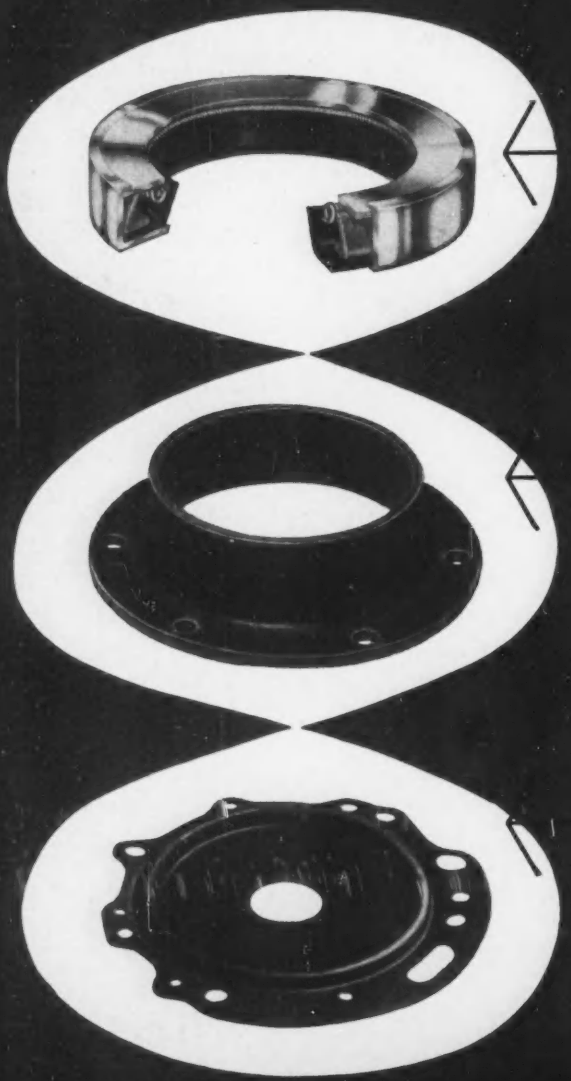

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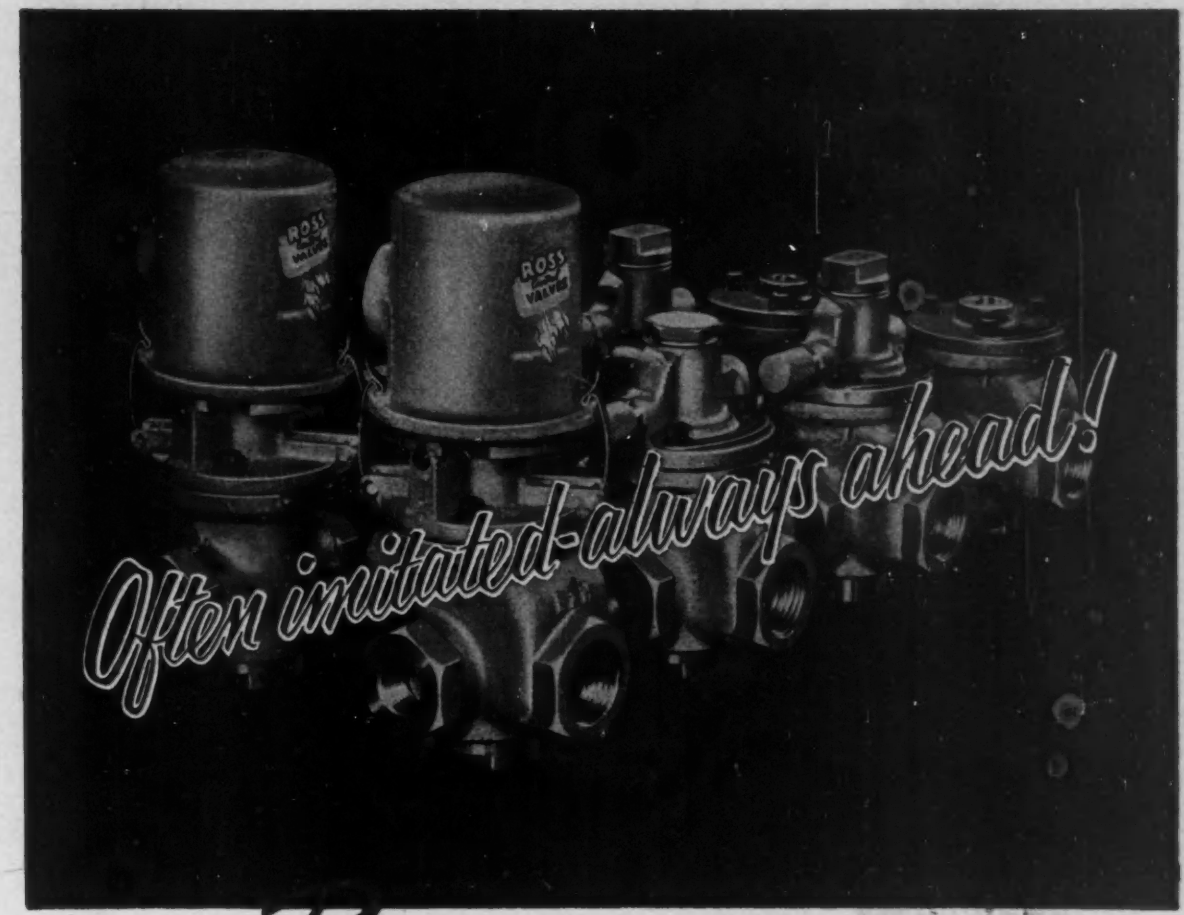

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Write for full information on the Ross In-line Series

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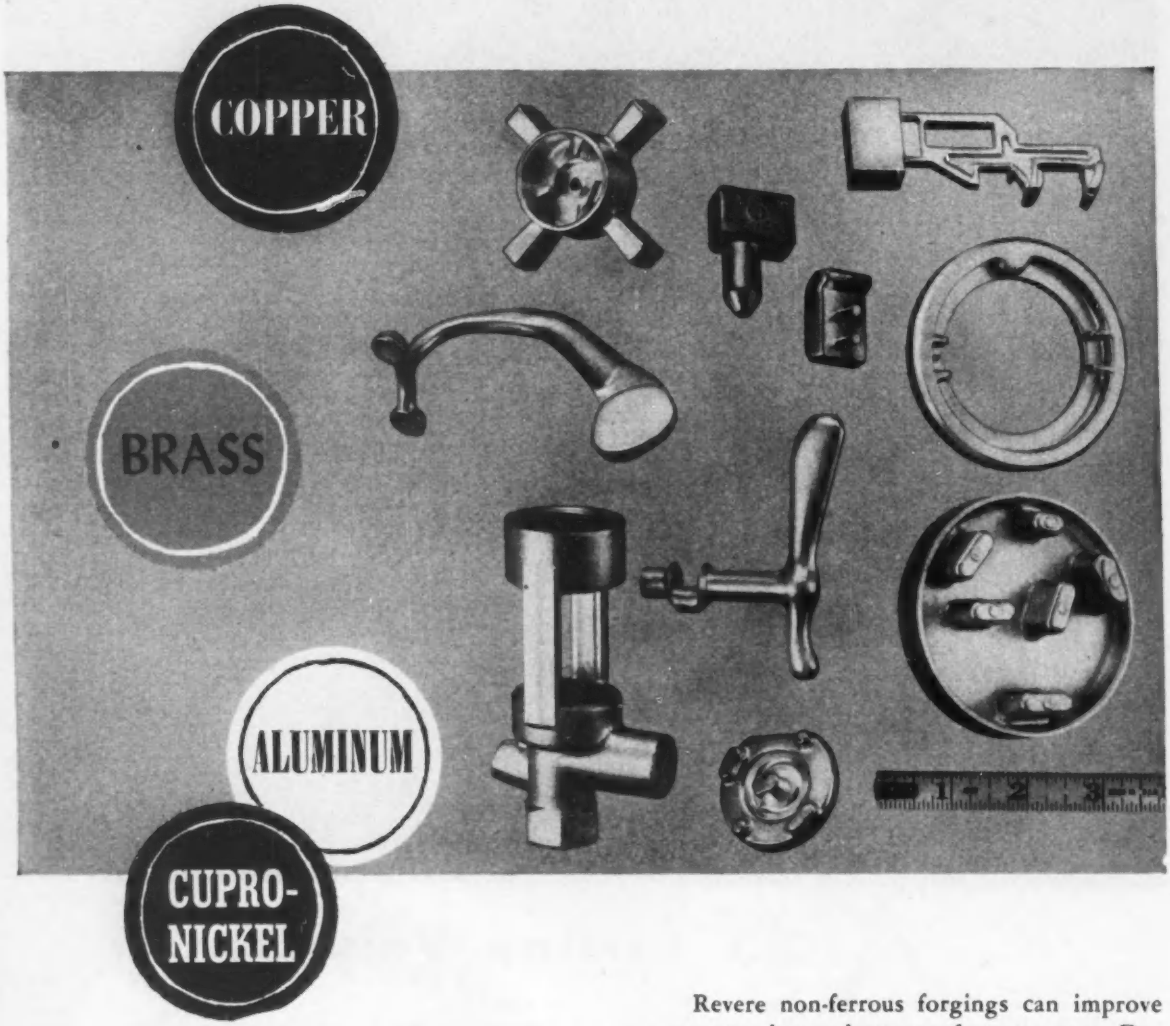

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Product Engineering

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THIS MONTH'S COVER

Pictured on this month's cover is an MDE (modular design of electronics) assembly developed by the National Bureau of Standards under sponsorship of the Navy Bureau of Aeronautics. Designed for completely automatic manufacture and assembly, these units represent an entirely new approach to the concept of printed circuitry. See page 134 for complete design and production details.

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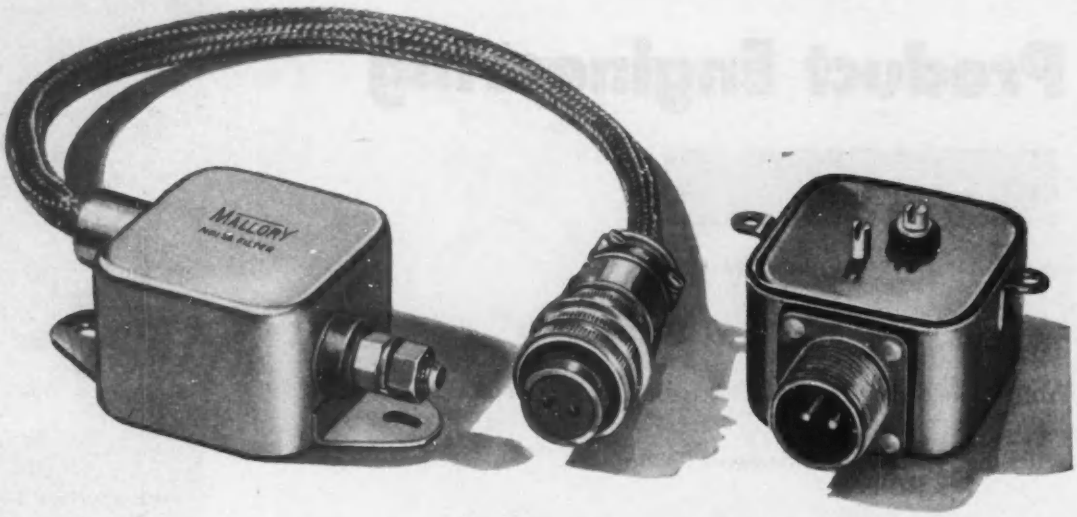
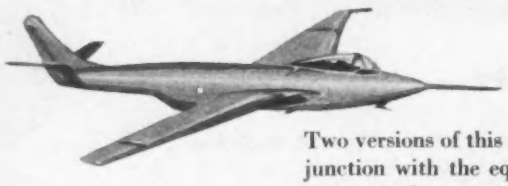


20 amp. 50 volt DC filters with extremely low DC resistance for aircraft equipment

Another example of Mallory filter engineering



Two versions of this filter are shown above. In conjunction with the equipment for which they were designed, they provide a minimum of 70 db attenuation from .15 to 100 megacycles. Effective attenuation is provided to 400 megacycles. Extra heavy gauge metal containers and oversize studs provide the rugged construction required by the application.

The exacting performance demanded by today's electrical and electronic equipment calls for radio noise filters that are carefully designed to match the equipment involved. The experience and skill of Mallory's engineering-production team is well equipped to analyze your problems and produce the right filter for your equipment. We will be glad to work with you on your specific requirements. Write or call us today.

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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear.

METALLIC MATERIALS

. . . . The first batch of alumina produced from Wyoming's reserves of the aluminum bearing ore, anorthosite, has been produced in a pilot plant operated jointly by the U. S. Bureau of Mines and the Monolith-Portland Cement Co. Based on the lime-soda-sinter process the alumina was reported to be of good quality, coarse in texture, and low in silica. The first batch, amounting to about 15 tons, was found to be 99.5 percent pure alumina.

INDIUM FOR SOLDER . . . .

. . . . Indium, a soft silvery metal, is a versatile solder useful for metals and non-metals. Georgia Institute of Technology reports that melting at 311 F indium has the dual ability of adhering to many metals when molten and continuing to stick to them upon solidification. It has been used to join 24 metals and 18 non-metals including common industrial metals, glass, ceramics, quartz, mica, metallic oxides and silicous minerals. Fluxes are not needed.

AL-TIN RESEARCH . . . .

. . . . A new alloy of aluminum with 30 percent tin may be a practical substitute for copper-lead bearings according to the Tin Research Institute, Middlesex, England. Advantages indicate that it can be used in contact with mild steel shafts that have not been specially hardened, it has good anti-friction properties and it is relatively cheap. It can be bonded to steel strip or to duraluminum backings.

BERYLLIUM ALLOY . . . .

. . . . A high strength, high conductivity copper base material of low beryllium content is being called Beryldur by the Beryllium Corp., Reading, Pa. The material in flake form is claimed to be especially suitable for fabricating operations where hot pressing is required because of its ductility.

TITANIUM IN IRON . . . .

. . . . The addition of titanium to iron is claimed to stabilize the carbon and provides a material for porcelain enameling that does away with the necessity of ground coat and gives a finish equal to multi-coat ware in appearance. According to Inland Steel Co. and Titanium Alloy Mfg. Co., the titanium enameled iron will withstand higher torsional stresses without cracking, is more resistant to chipping and does not show strain lines or welts in areas critically strained, on products fabricated by drawing.

NEW CARBIDE . . . .

. . . . Heavy-duty, steel-cutting grade cemented carbide that is expected to step up machining operations as much as 30 percent has been developed by the Carboloy Department of G.E. The new grade was developed for heavy cuts at high tool temperatures. It is reported capable of removing more cubic inches of steel per minute while providing up to 50 percent longer tool life than existing grades.

TITANIUM CASTING . . . .

. . . . Castings in both pure and alloyed titanium weighing up to several pounds have been produced in pilot quantities by The National Research Corp., Cambridge, Mass. Carbon, oxygen and nitrogen content are claimed to be reasonably comparable with commercial wrought titanium. The process is the result of development of special vacuum melting furnaces, casting procedures, and mold materials capable of withstanding attack by molten titanium.

COMPONENTS

. . . . Junction type transistors are now being produced with a rejection rate of less than 50 per 1,000 units. Raytheon Mfg. Co., Chicago, Ill., reports that transistor rejection rate is less than comparably rated electron tubes. These units are the milliwatt type used in hearing aids and similar applications.

LOW PRESSURE GOLD DISKS . . . .

. . . . Development of a low pressure rupture disk from gold has been accomplished by Baker and Co., Newark, N. J. Normally made of platinum, the gold disks offer the same benefits but being softer permit lower burst pressures. The new disk has a burst pressure of 18 lb, has a 4 in. dia and a thickness of 0.002 in. Precious metal is immune to chemical attack and will burst regardless of its length of service.

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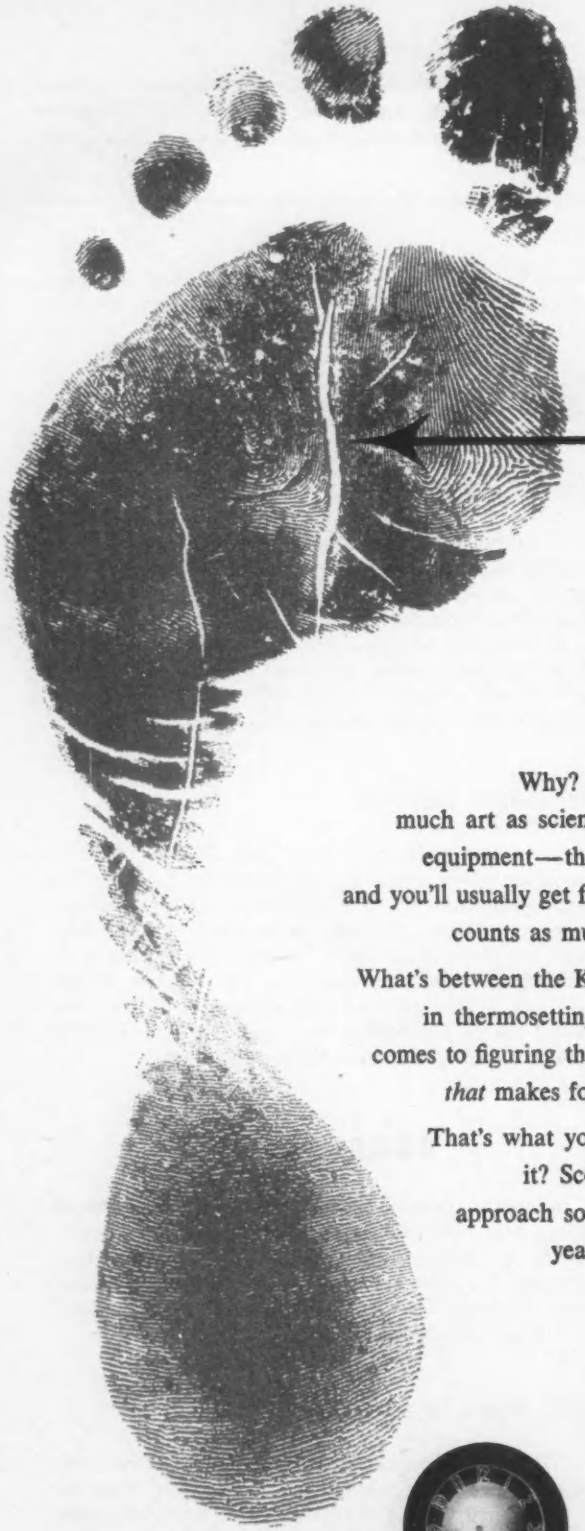

In Plastics

This is what a Moulding Job is Absolutely As Individual As

Why? It's an unusual business, moulding plastics—still as much art as science. Give five custom moulders the same presses and equipment—the same material sources—the same set of drawings—and you'll usually get five sets of results. What's between your moulder's ears counts as much—but varies as much—as what's at his fingertips.

What's between the Kurz-Kasch corporate ears is 37 years of specialization in thermosetting moulding. That makes for some orneriness when it comes to figuring the best and least expensive way to tackle your job. But *that* makes for most pleasing results in quality, price and deliveries.

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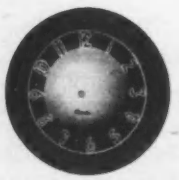

Urea clock case, 1-piece compression-moulded, for Westclox —a 10-year-plus KK customer.

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Highlights ~

TENSION METER . . . .

. . . . A new tension meter covering a capacity of 20 lb or more has been designed by Tensitron Inc., Harvard, Mass. The meter is designed to accommodate ball bearing rollers of any reasonable width so as to measure the tension of rayon and similar materials up to 2 in. wide and also strips of moving picture film, insulated and narrow fabric and paper tape. A basically new movement is used, states the manufacturer, in that gear trains and other sensitive equipment have been omitted to decrease maintenance.

PLASTIC ACCUMULATOR . . . .

. . . . A Fiberglas-Epon resin reservoir with a burst strength of 7,000 psi has been developed jointly by Bendix Aviation, Teterboro, N. J. and Apex Electric Mfg. Co., Cleveland, Ohio. The unit has a container-to-air ratio of 2:1 weighing 16 lb empty as compared to steel units that weigh about 25 lb empty. The reservoir holds 8 lb of air at 3,000 psi and has passed fatigue tests by going 26,000 cycles without failure. Present unit, for a jet engine starter system, has a 13 in. dia with walls three-quarters in. thick.

RECTIFIER . . . .

. . . . A small compact unit that provides d-c from an a-c source is a development of the American Rectifier Corp., New York, N. Y. The rectifier can be plugged into any a-c outlet and thus eliminates the need for discarding small d-c operated machinery when a source is not available. The unit uses a selenium cell for converting action and has no tubes or rotating parts, such as brushes or bearings.

TESTING

. . . . The emission spectrograph using standard samples made by the fusion technique can be used for analytical control methods for titanium and its alloys. National Spectrographic Laboratories, Inc., Cleveland, Ohio states that high dispersion spectrograms are required because of the complexity of the titanium spectrum and that of its alloys.

CREEP DEFORMATION OF ALUMINUM . . . .

. . . . Investigations have led to further proof that the mechanism of coarse grain, high purity aluminum is complex and that no single equation can be written to express creep behavior. Tests made at the Mass. Institute of Technology, Cambridge, Mass., indicates that any equation intended to define a conventional creep curve must be considered to be a statistical summation of equations describing the various component processes. While boundary deformation is significant from the start for specimens tested at 700 and 1,100 F, at 400 F boundry slip was only pronounced in the later stages. A cyclic behavior was observed in all tests made—as creep progressed, this periodicity was observed to increase but the deformation per cycle became less for the aluminum tested.

X-RAY TO STUDY METAL . . . .

. . . . The cause of brittleness in steel and other metals at low temperatures is being studied at the University of California at Los Angeles. A special low temperature X-ray defraction apparatus has been developed to study the crystalline process by which some metals become brittle at low temperatures. A super freeze is maintained by circulating liquid nitrogen through a tubular specimen that is being rotated under load. X-ray pictures of the deformation of the specimen are recorded by a special camera attached to the apparatus.

POWDER METALLURGY RESEARCH . . . .

. . . . Investigation into recrystallization and grain growth during sintering of powder metal parts is a project to be undertaken by a research group at Sylvania Electric Products Inc., Bayside, N. Y. Basic studies are also to be made into the preparation of alloys by powder metallurgy, and the effect upon the powder of friction and lubrication when compacting.

CREEP BEHAVIOR OF MAGNESIUM . . . .

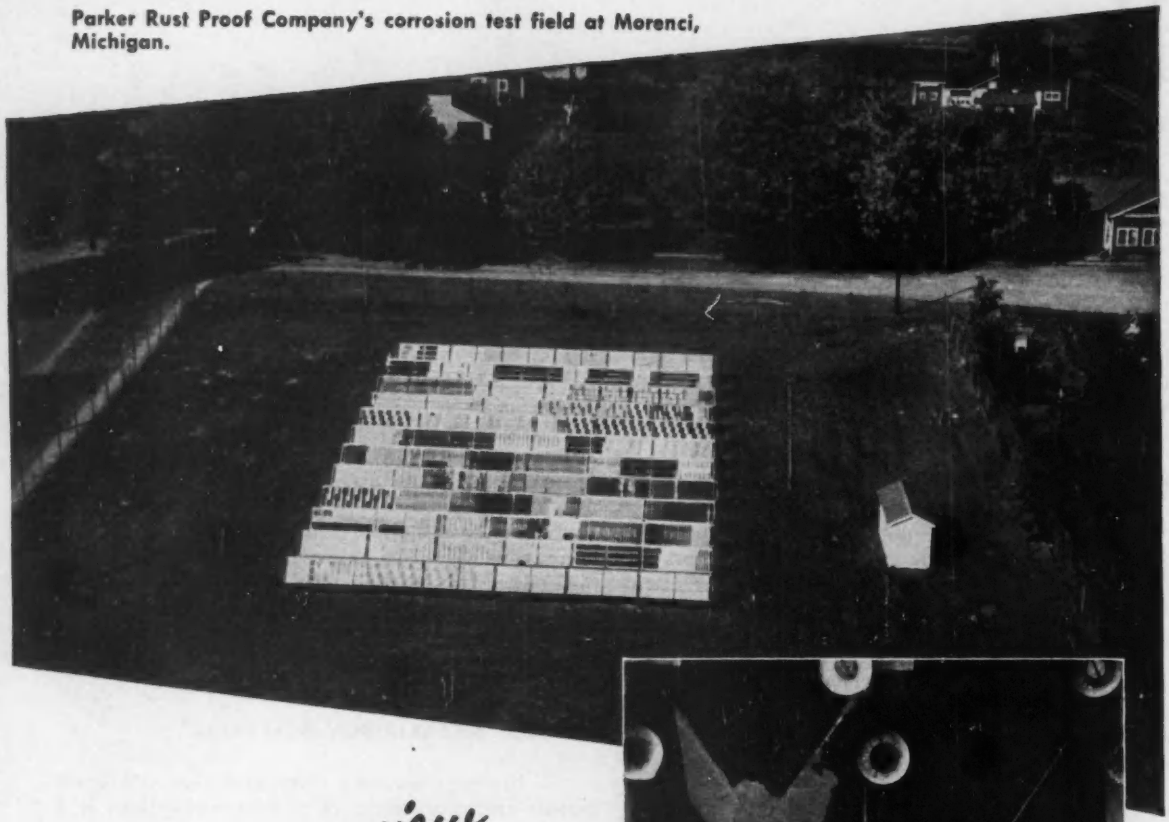
. . . . Recent tests indicate that the creep of polycrystalline extruded electrolytic magnesium is a complex mechanism. Dow Chemical Co., Midland, Mich., reports that in the temperature range of 200-600 F creep consists of both transient and steady-state elements. The former is of primary importance at low temperatures and/or high stresses; the latter, at high temperatures and/or low stresses.

TITANIUM LABORATORY . . . .

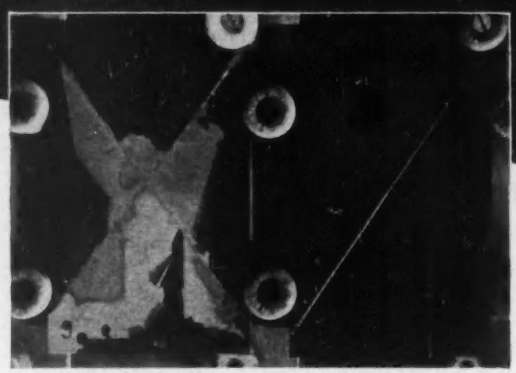
. . . . Research and development devoted exclusively to titanium will be carried on at the industrial laboratory of Mallory-Sharon Titanium Corp., Niles, Ohio. The laboratory will engage in basic research, development of titanium and titanium alloys and production testing. The facility includes a complete chemical laboratory, metallographic and spectrographic equipment, mills for hot rolling test specimens, furnaces for heat treating and melting, and an X-ray diffraction unit. The laboratory will assist in the testing and development of products of titanium.

(continued on page 9)

Parker Rust Proof Company's corrosion test field at Morenci, Michigan.



Birds-eye view of a strange crop



What weather does to finishes! Panel left, paint over untreated aluminum. Panel right, paint over Bonderite-treated aluminum. 11 months outdoor exposure.

A crop of 6,400 metal panels is tended in Parker Rust Proof's outdoor test field. The harvest is facts on the durability of various finishes over various metals.

Conditions here are the same as are met by painted products in daily outdoor use. The sun and the wind, the rain, sleet and snow pound at these panels continually. Parker technicians watch each set of panels individually, observe their condition, chart results at regular intervals.

This large-scale outdoor testing program, continuous since 1935, has helped build Parker's great fund of valuable information on how to control corrosion. The facts we learn from the corrosion test field are passed on to guide our customers to more effective, more economical surface treatments for metals.

*Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.

Since 1915—leader in the field

PARKER RUST PROOF COMPANY

2179 E. Milwaukee Ave., Detroit 11, Michigan

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces

Highlights ~

NONMETALLIC MATERIALS

. . . . Development of an automotive fuel that contains as its most important ingredient magnesium powder is being carried on by the Reade Mfg. Co., Jersey City, N. J. It is claimed that one lb of the new fuel would supply as much power as 10 gal of gasoline. However, it would require a different type of engine—one that would have only 1/3 as many moving parts as present automobile engines and that would cost considerably less to produce than present engines.

GASKET MATERIAL . . . .

. . . . Combining the resilience and high temperature properties of silicone rubber with the chemical resistance of fluorocarbons the gaskets are a development of the Connecticut Hard Rubber Co., New Haven, Conn. Strip gaskets can be made in either sponge or solid rubber with various durometers. The silicone core is protected from chemical attack by the plastic envelope that ranges in thickness from 0.0025 to 0.030 inches.

RAPID DRYING . . . .

. . . . A new technique for the rapid drying of protective and decorative coatings of inks, paints and varnishes has been developed by Armour Research Foundation for Meyercord Co., Chicago, Ill. The process is claimed to shorten drying time on coated products from 24 hr to between 2 and 20 seconds. Drying is accomplished by chemical reaction between coating and sulfur dichloride vapor instead of by commonly accepted polymerization or oxidation.

CERAMIC COATING . . . .

. . . . A recently developed ceramic coating is being used for jet engine components that can withstand temperatures to 3,000 F. G.E.'s Hotpoint Division, Chicago, Ill., is studying the coating for possible use on non-critical and low alloy content materials for heating elements on stoves, dryers and other equipment using heating coils.

PROCESSES

. . . . Unless the oxides are removed from titanium after heat treating and forging the corrosion resistance is reduced, welding is difficult and ductility is diminished. Work done by G. E. Thomson Laboratory, indicates that specially compounded molten caustic baths offer good possibilities. When the scale is light a dip in 15 percent H_2SO_4 followed by a water rinse and a dip in a solution containing 3 parts HNO_3 and 1 part HF followed by a second water rinse is satisfactory. Heavy scale requires immersion in Virgo salts, treated in a bath of Kolene No. 4, rinsed in water, dipped in a nitric-hydrofluoric acid and then water rinsed. Time and temperature vary for heavy scale formed above 1,300 Fahrenheit.

STEEL EXTRUSION . . . .

. . . . An economic method for the hot extrusion of alloy steel shapes at temperatures up to 2,300 F and lengths up to 30 ft is claimed by Harvey Machine Co., Torrance, Calif. Excellent surfaces and tolerances are reported for the extruded shapes. The process requires specially designed extrusion dies and specially developed lubricants to extrude the steel.

HOT DIP ALUMINIZING . . . .

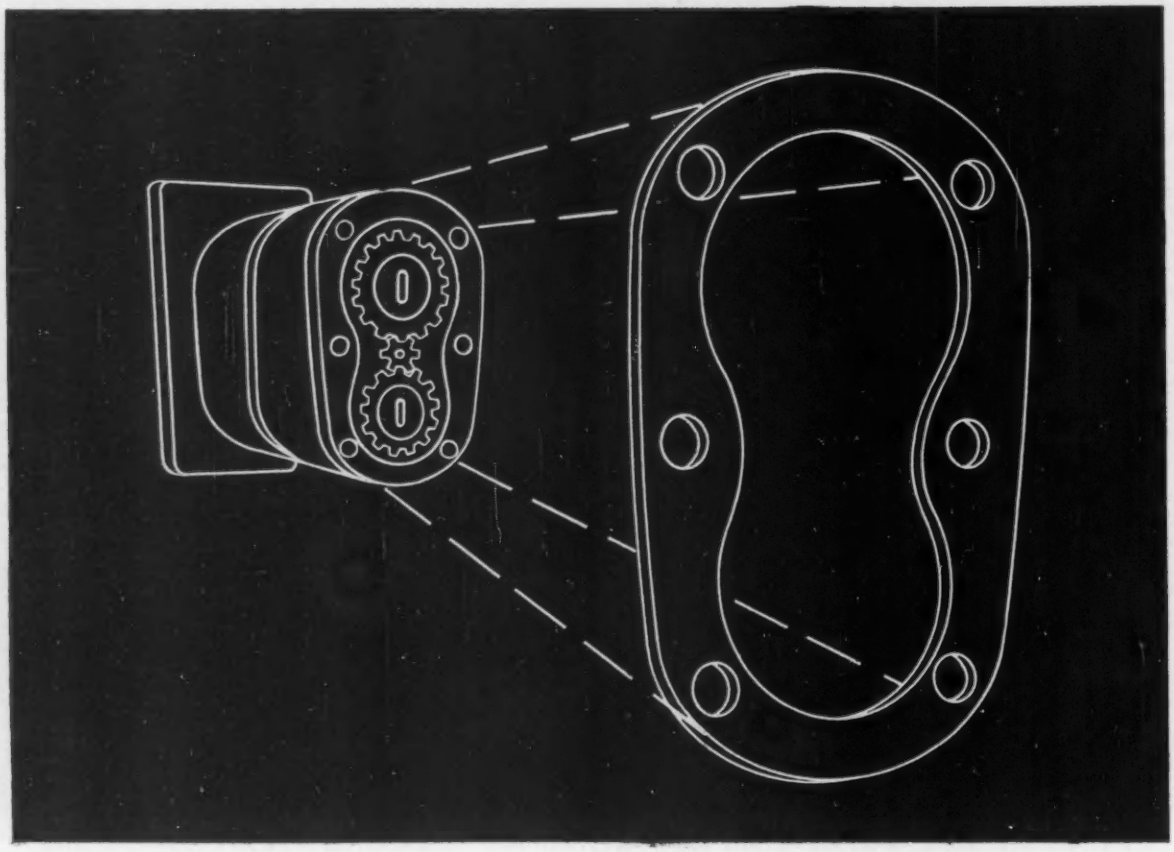
. . . . A simplified process for continuous hot dip aluminizing steel has been developed by the British Iron and Steel Research Association, South Wales Laboratories. The process has been successfully tested in experimental batches and in pilot plant operation. Clean cold-rolled strip is passed through a vapor degreaser, scrubbed, washed and pickled. After pickling the strip or wire is drawn through rollers where it is coated with a solution of glycerol thinned with alcohol and then passed through the bath of molten aluminum and coiled.

MORE ZIRCONIUM . . . .

. . . . A commercially practical method for refining zirconium is expected to increase the supply for industrial applications. The process equipment will be used at the Akron, Ohio plant of the Carborundum Metals Co., Inc. Zirconium will then be available for chemical equipment, pipes, valves, tubes, and pump liners as well as for construction material for atomic energy reactors by the Atomic Energy Commission.

TITANIUM STAMPINGS . . . .

. . . . Stampings are being made at room temperatures by using tools of conventional design by The Worcester Pressed Steel Co., Mass. Initial reductions up to 40-45 percent from blank diameter to cup diameter are reported with further reductions of 15 to 25 percent on redraws. The material must be stress relieved and annealed after each drawing operation as it work hardens rapidly. Pressures required are greater than those used for mild steels and the rate of drawing must be reduced to rather low values. Examples of drawn parts are mortar bases, primer cups, storage tanks for nitric acid and jet engine shields. Other titanium parts are being investigated.



New fiber gasket keeps food clean

When you mix salad oil with lubricating oil, you get an "explosive" mixture. At least that's what one manufacturer of commercial food processing machinery discovered when complaints began to roll in from customers who didn't relish the contamination caused by leaky gaskets.

Investigation showed that the fiber gaskets then being used tended to wick. Over a period of time, too, they'd dry out, shrink, and then begin to leak. Since their replacement gaskets dried out also during storage, leaks were chronic.

In a field where no leaks at all can be tolerated, this manufacturer had to find a sound yet economical answer to his problem. He got it in Armstrong's new fiber material—Accopac®.

Months of careful field testing proved that, with Accopac gaskets, lubricating oil and grease stayed where it belonged, where it could lubricate and not contaminate.

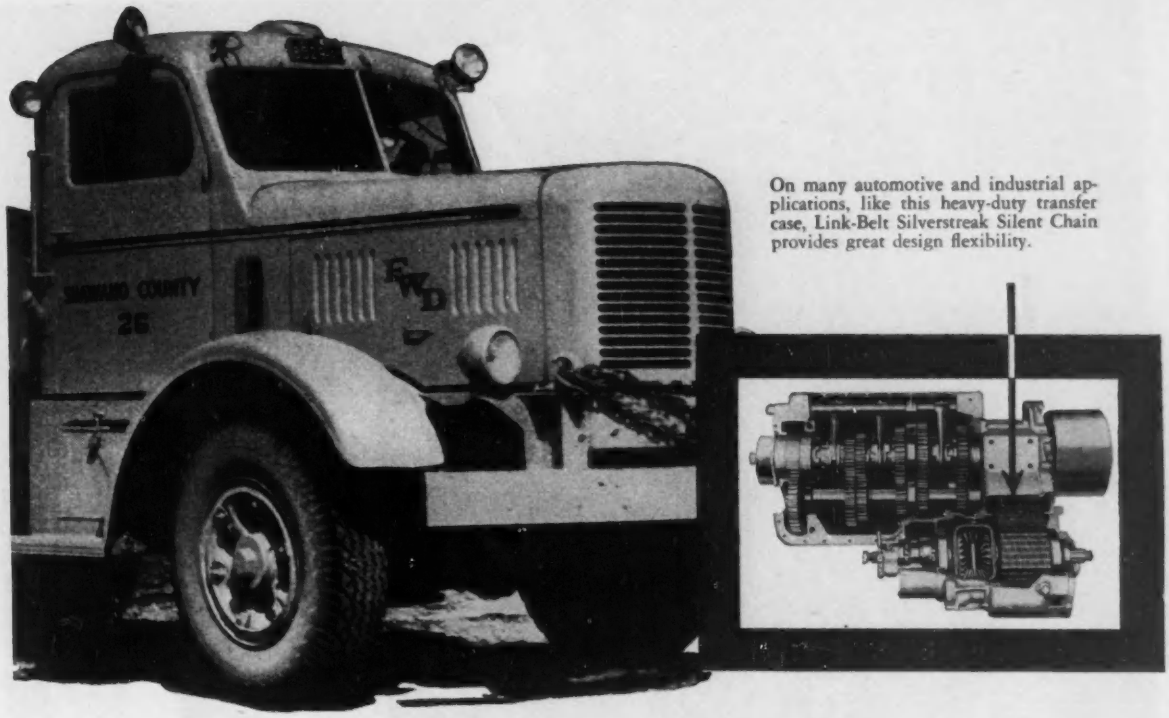
Now more than thirty different Accopac gaskets are used on this food processing equipment. Of course, replacement gaskets, too, are now made of Accopac because they don't deteriorate.

Won't shrink or dry out. Accopac is a new kind of fiber gasket material. Its rubber latex binder goes into the beater before the sheets are formed. This patented process locks the fibers in rubber, makes Accopac impervious and dimensionally stable, while its cork content adds compressibility.

Today, Accopac is being used in thousands of applications—in gasoline engines, in pumps, aircraft, washing machines—wherever there's a need for efficient sealing at low cost.

FREE GASKET MANUAL. For details about Accopac and other gasket materials, send for free, 24-page manual, "Armstrong's Gasket Materials." Contains latest specifications as well as data on the design and use of gaskets. Write Armstrong Cork Company, Industrial Division, 7012 Irvin Street, Lancaster, Pennsylvania.

ARMSTRONG'S ACCOPAC



On many automotive and industrial applications, like this heavy-duty transfer case, Link-Belt Silverstreak Silent Chain provides great design flexibility.

Design for sustained high efficiency at high speeds

with LINK-BELT Silent Chain

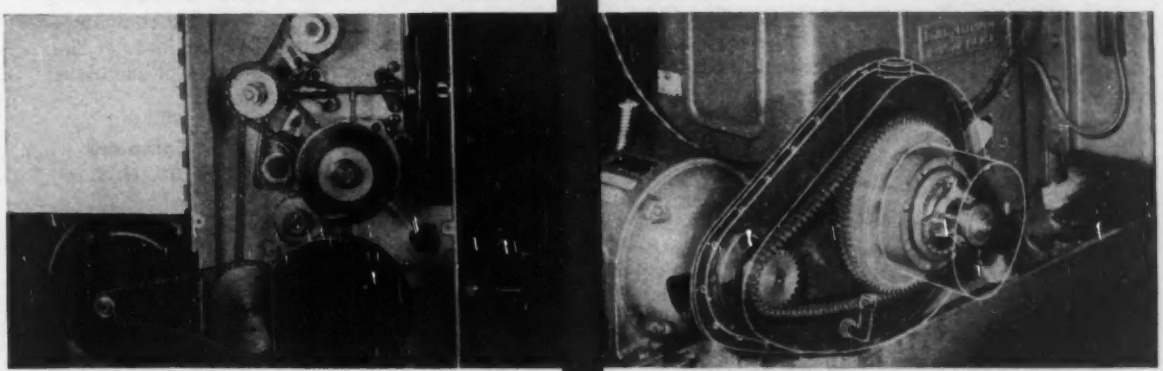
From fractional to thousands of hp--your assurance of dependable, positive transmission

LINK-BELT Silent Chain gives you a positive, no-slip, constant-speed drive. Even at high rotative and linear speeds, its better-than-98% efficiency is maintained throughout the long life of the drive. For design information on Link-Belt Silverstreak Silent Chain Drives, get in touch with the Link-Belt office near you.

LINK-BELT

SILVERSTREAK SILENT CHAIN DRIVES

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities. 13,243



For constant-speed, quiet, smooth operation, Link-Belt Silent Chain is the answer. Here 3/16-in. pitch chain synchronizes sound with picture in a motion picture theater projector. Exclusive link and tooth form eliminates chordal disturbance.

Constructed entirely of steel and completely enclosed in an oil-tight casing, Link-Belt Silent Chain provides many years of high efficiency at low cost. This universal shaper is driven with Silverstreak Silent Chain (casing shown in "phantom").

DIE CAST

ZINC

for DE VILBISS

Here's Why .....

The unusual combination of cored openings, decorative effects and engraved lettering called for in this part were best obtained as a ZINC Die Casting. Furthermore, it is important that the part be highly corrosion-resistant and of sound structure to withstand up to 300 pounds per square inch of air pressure without a bubble of leakage. No other metal or method of fabrication could provide all of these physical characteristics at a cost comparable with ZINC Die Casting.

This casting — the regulator head for the pictured De Vilbiss air transformer, which feeds compressed air to spraying and other equipment with a high degree of uniformity and accuracy — requires an absolute minimum of secondary operations prior to assembly, thanks to the unusual castability of ZINC. And the as-cast surfaces of this casting are plated easily and economically.

The De Vilbiss air transformer is just one of countless products made better with ZINC die castings. Ask us — or any die casting company — for a copy of our booklet "The End Uses of Zinc Die Castings" which has 48 pages of successful ZINC die casting applications.

ZINC IS FREELY AVAILABLE

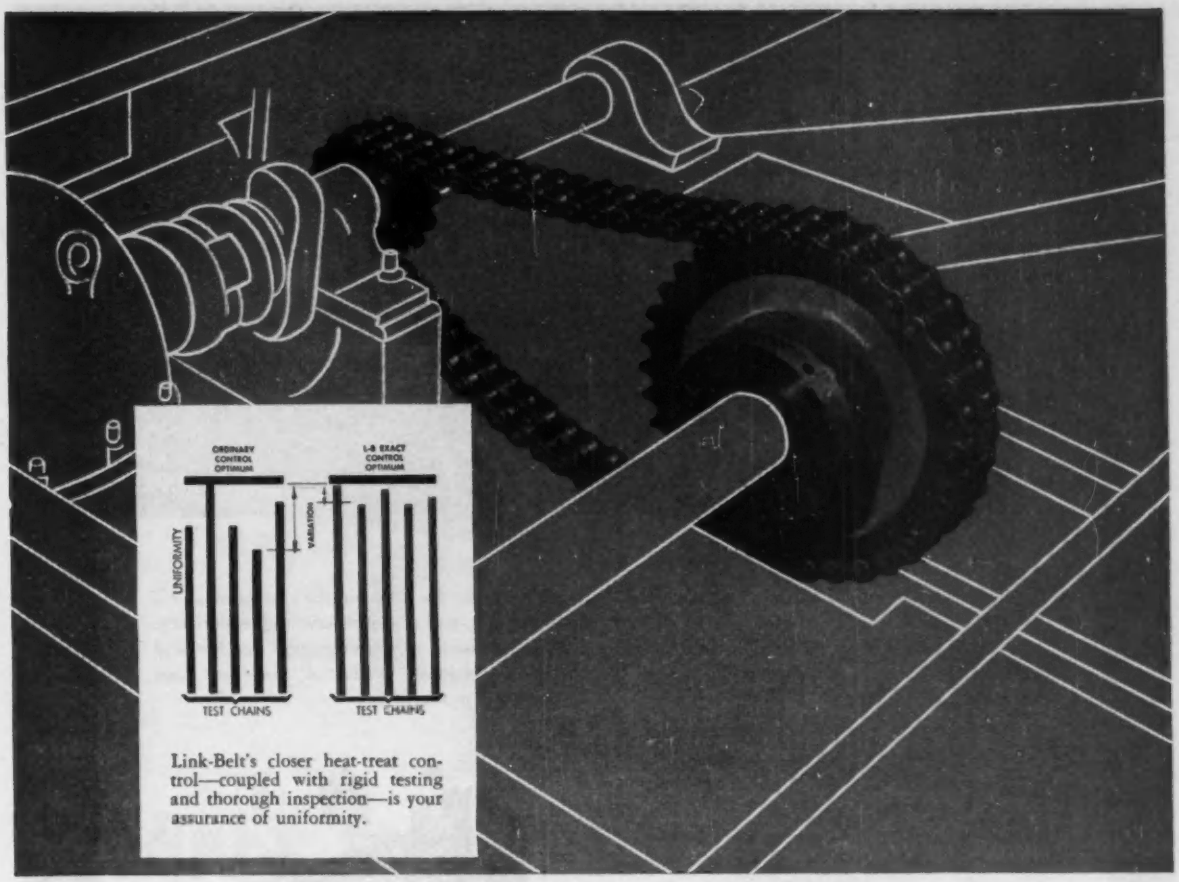
The American Zinc Institute has issued a new folder which gives the facts on why "zinc supplies will continue to be sufficient to meet both near and long range requirements". Ask us for a copy.

The New Jersey Zinc Company
160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC



Link-Belt's closer heat-treat control—coupled with rigid testing and thorough inspection—is your assurance of uniformity.

Closer heat treat control means longer roller chain life!

But it's only one of many engineering extras you get from LINK-BELT

THE long-life record of Link-Belt Precision Steel Roller Chain is based on more than closer heat treat control. Consider such extra-wear features as shot-peened rollers and lock-type bushings. They're further assurance of Link-Belt's *built-in* extra life.

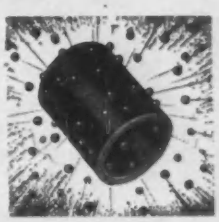
Link-Belt Roller Chain is available in single or multiple widths, ⅜″ through 3″ pitch. Double pitch, 1″ through 3″. For all the facts, call the Link-Belt office near you today, or write for Data Book No. 2457.

LINK-BELT

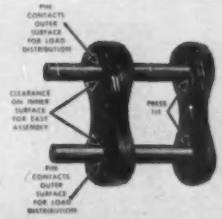
ROLLER CHAIN & SPROCKETS

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 13,120

Don't overlook these other LINK-BELT extras



Shot-peened rollers have extra fatigue life for higher speeds, heavier loads.



Couple, uncouple multiple-width chains easily.

Lock-type bushings assure free articulation.

24 HOURS OF "BACK TALK"

...but none about these die-cast parts

CASE HISTORIES FROM MT. VERNON FILES

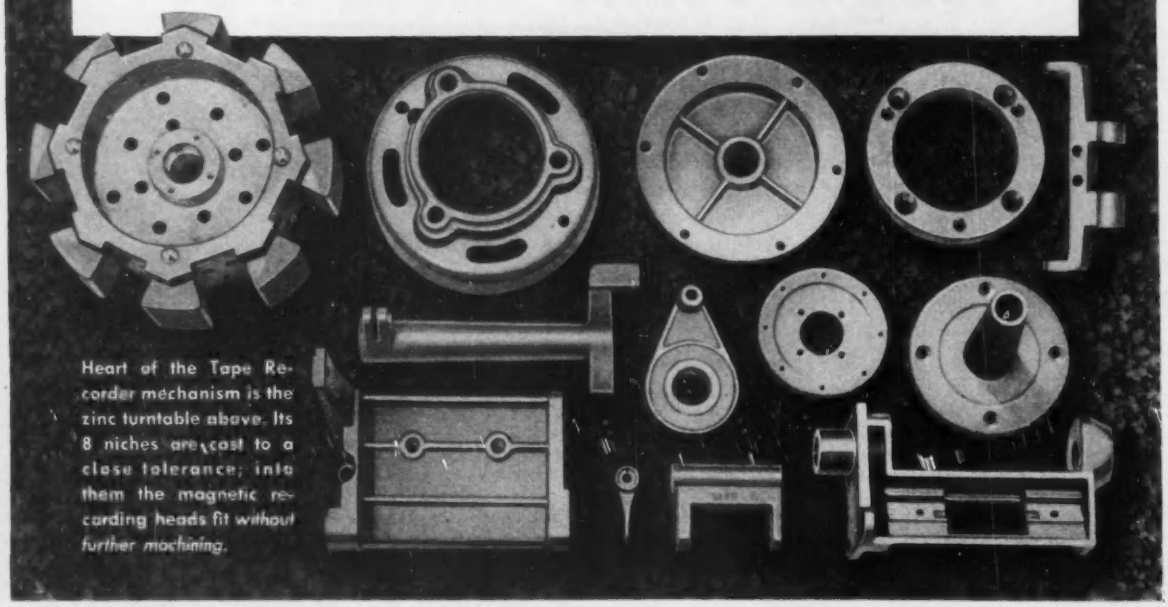
Soundscriber's new 24-hour Magnetic Tape Recorder and Reproducer is the first in its field to provide such a long period of continuous, unattended recording in so small an instrument. It weighs but 80 pounds.

One important reason why this precision instrument is so light, so thoroughly practical, yet so moderate in cost, is the die cast aluminum and zinc parts you see here.

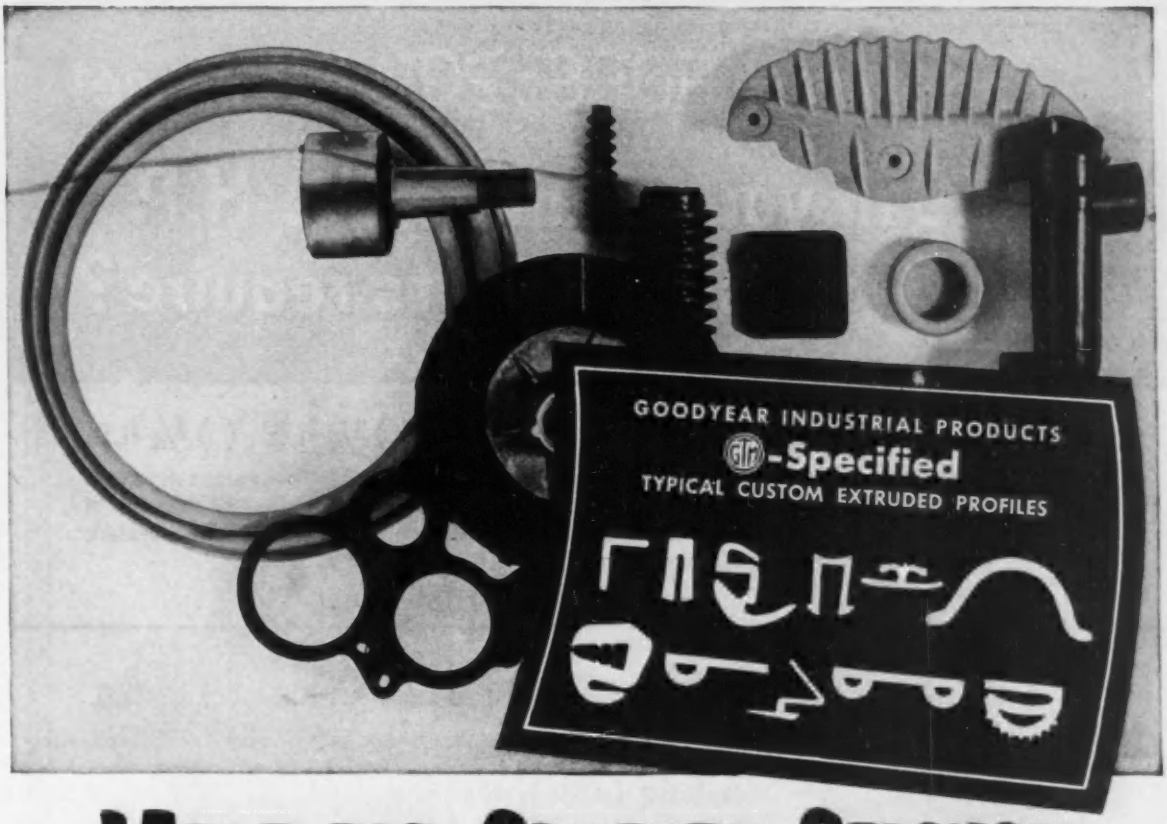
States Soundscriber Corporation: "From long experience with our standard line of dictating equipment, we have found die casting a lower-cost way of making intricate parts. Further, this method allows for more economical use of light-weight metals. Mt. Vernon die casting has always met our high quality standards."

Whatever *your* product, simple or intricate, it will pay you to consult with us. We have up-to-the-minute facilities for precision die casting of aluminum and zinc, and a vast reservoir of experience. It's quite possible that we can show you the way to greatly increased production, lower unit costs —improved products, too.

MT. VERNON
DIE CASTING CORP.
MT. VERNON, NEW YORK



Heart of the Tape Recorder mechanism is the zinc turntable above. Its 8 niches are cast to a close tolerance; into them the magnetic recording heads fit *without further machining.*



MADE FOR GREATER SERVICE

through greater service

Greater service from custom molded or extruded rubber parts comes from the greater service Goodyear gives you throughout their design and production.

From drawing board to delivery, your product gets the special attention of Goodyear's experts in getting the most out of rubber.

The G.T.M.—Goodyear Technical Man—serves you with his long and varied experience in designing rubber to do a better job longer in many uses in many industries.

Goodyear's corps of chemists and engineers serve you with their complete knowledge of compounding and processing rubber to meet virtually any specification or service requirement.

And thousands of production workers serve you with their unparalleled experience in turning out all types of rubber parts—on time and on "spec"—with modern equipment in modern plants.

For greater service from parts made of rubber or rubber-like plastics—or combinations of rubber and metal, rubber and fabric or rubber and plastic, use the greater service offered by Goodyear. Consult your G.T.M., or write to Goodyear, Molded Goods Dept., St. Marys, Ohio or Los Angeles, California.

YOUR GOODYEAR DISTRIBUTOR *can quickly supply you with Hose (air, water, steam, oil, special), Belting (V-belts, transmission, conveyor, elevator), and other industrial rubber products. Look for him in the yellow pages of your telephone directory under "Rubber Products" or "Rubber Goods."*

GOODYEAR

THE GREATEST NAME IN RUBBER

We think you'll like THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

your HORSEPOWER sense!

Can you estimate the H.P. these products require?

CHECK ONE: ( ) 3/4-h.p. ( ) 1/2-h.p. ( ) 1/3-h.p. ( ) 1/4-h.p.

Two right answers here! That's because the majority of home freezers are powered with motors of one-fourth or one-third h.p. Delco is a pioneer manufacturer of hermetic motors for freezers and refrigerators . . . motors famous for dependable service over the years.

CHECK ONE: ( ) 1/6-h.p. ( ) 1/4-h.p. ( ) 1/3-h.p. ( ) 1/2-h.p.

Right! The one-third h.p. motor is most favored by lawn mower manufacturers. And Delco Motors are favored, too—for their dependability and long life, as well as their ease of application to any product design.

CHECK ONE: ( ) 1/6-h.p. ( ) 1/4-h.p. ( ) 1/3-h.p. ( ) 1/2-h.p.

That's right—one-third h.p. motors are the popular ones when it comes to powering cellar drainers. Where dependable, trouble-free service counts, Delco Motors are the long-time favorites. Manufacturers know the Delco name gives their products added value.

DELCO

The best running mate your product can have!

DELCO PRODUCTS

Division of General Motors Corporation, Dayton, Ohio

SALES OFFICES: Atlanta • Chicago • Cincinnati • Cleveland • Dallas Detroit • Hartford • Philadelphia • St. Louis • San Francisco

BIG SCOREBOARD

for Scores of Manufacturing Processes

Added Evidence that —

Everyone Can Count on VEEDER-ROOT

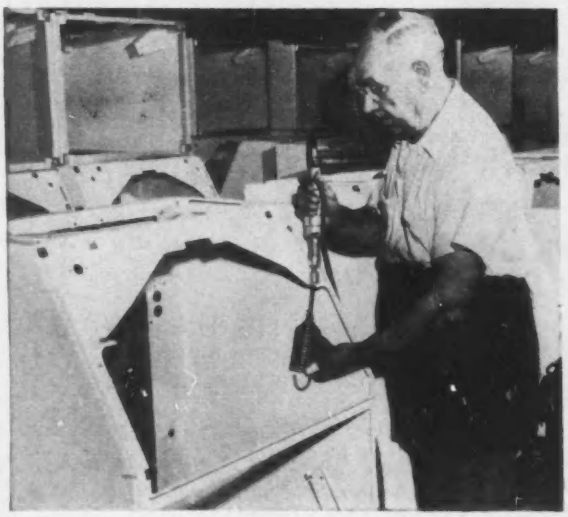
This husky long-lived Box-type Counter is available with 6 figures, in either the ratchet model, or in the new *geared* model with bearing inserts. This new gearing permits speeds of 1,000 counts per minute, which makes the counter adaptable to practically any manufacturing process where large figures are wanted for easy reading at a distance. Figure out how this counter can be *built into* your product as a new sales advantage over competition. Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

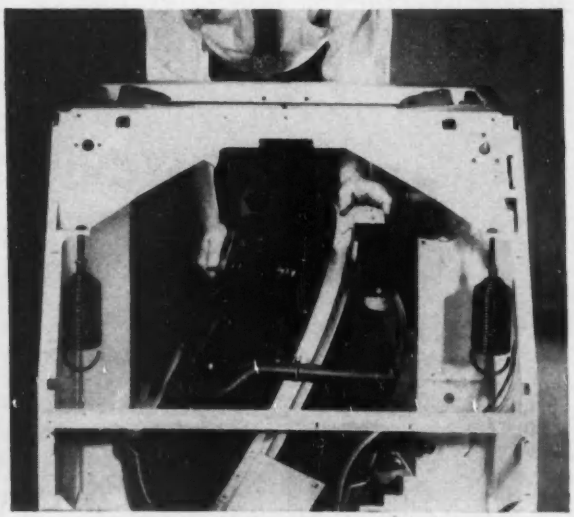
"The Name that Counts"

Over 1,000,000

OVER A MILLION families wash their clothes in Laundromats. Westinghouse also does a big export business, so these machines have to be trouble-free.



HERE, a man installs the main suspension springs. The springs are periodically tested to meet severe 450 c.p.m./⅝-inch amplitude, vibration tests.



AS UNIT IS INSTALLED in shell, man holds top damper spring. Notice damping blocks on end of flat spring to reduce excess movement.

Laundromats in use, but...

"We've never had a failure with American Quality Springs"

says *WESTINGHOUSE ELECTRIC CORPORATION*

THE Westinghouse Laundromat has been a household word ever since the first unit rolled off the production line in 1940. Since then, Westinghouse has produced over 1,125,000 Laundromats. Despite many important improvements, the superb spring suspension system has stood the test of time. It's the same today as it was in 1940, because it was designed so well in the first place.

Three different styles of American Quality Springs are used in the Laundromat. The *coil* springs support the entire weight of the machine within its shell. The *flat* steel springs contain friction dampers that limit excessive movement caused by an unbalanced load during the spin-dry cycle.

Failure of a coil spring could damage the entire machine. At the least, it would mean an expensive service call. But, because of the efficient design, and the completely reliable American Quality Springs, *no spring has ever failed in a Westinghouse Laundromat.*

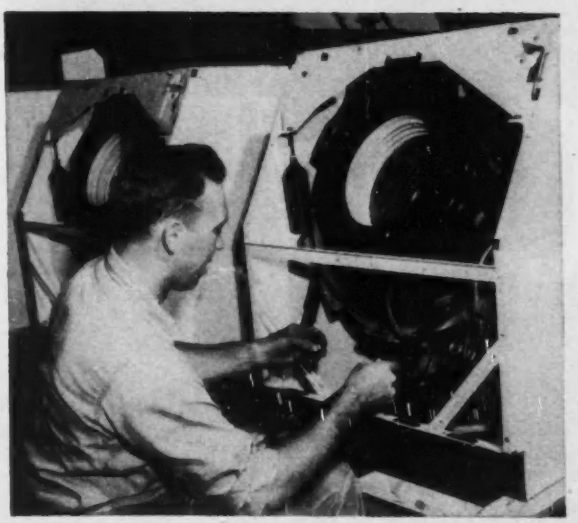
If service like this makes sense to you, get in touch with your nearest American Steel & Wire representative. We make all kinds of springs, any steel, any finish. And you'll get the same kind of quality that Westinghouse gets.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

U·S·S American Quality Springs

UNITED STATES STEEL



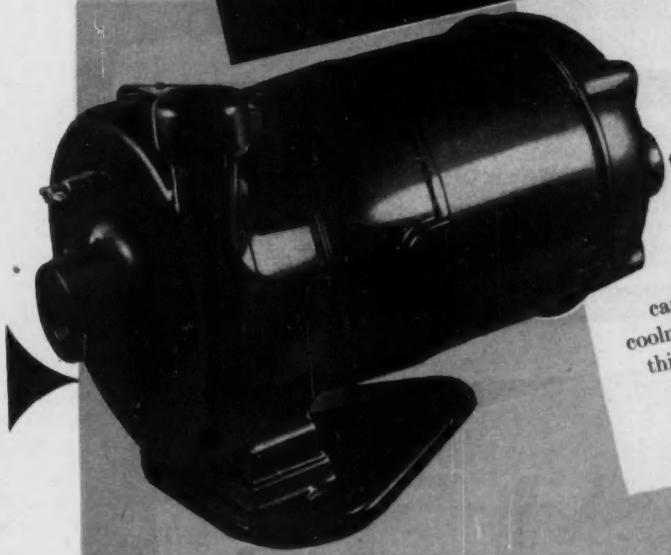
BOTTOM DAMPER springs are installed. Because of the entire engineered suspension, Laundromat was one of the first washers that didn't have to be bolted to floor.

WESTINGHOUSE LAYS DOWN rigid specifications for their American Quality Springs, proving their motto, "Quality must be *built* into a product."

more
and more
pumps
are powered
by HOOVER

for every electric motor need, up to

5 h.p.



ALLIS-CHALMERS PUMPS FOR AIR CONDITIONERS

"In setting the many requirements of the motor to be used on our pump for the air-conditioning industry, we decided that it must first be compact so that we could hold down the size of our unit. We had also set specific torque standards and in addition required ample overload capacity. Above all, we wanted dependability, coolness, and economy in operation. With all these things considered, we were more than willing to specify Hoover motors for our pump units."

Allis-Chalmers Manufacturing Company

Another big pump maker joins the list of major manufacturers specifying Hoover electric motors! And thousands of buyers of air conditioning get dependable and economical results!

Hoover electric motors are famous for compactness—full-rated horsepower in smallest possible space. For their insulation—they run cool, stay cool, even on hot and heavy jobs. For their starting switch, rigid housing, rugged and simplified internal construction—which all add up to long and trouble-free life.

Most important, perhaps, Hoover motors have earned a world-wide reputation for economy—they cut original and operating expenses. And if trouble ever strikes, a nearby Hoover service station takes care of repair for lowest maintenance costs.

If you make, or help make, any product calling for a fractional or integral horsepower electric motor, check with Hoover before you decide. The current Hoover catalog lists dozens of low-cost, in-production models in stock or available on short notice. Or Hoover engineers will work with your engineers to tailor-make your motor to your most exacting mechanical and electrical details.

PRODUCTION FOR HOME AND DEFENSE
Week in and week out, Hoover is producing a very substantial volume of essential materials for the Armed Forces.

WRITE YOUR OWN TICKET...

Send this coupon now for a free copy of the current Hoover catalog and for full information on the engineering services available for electric motor users. No obligation, of course.

THE HOOVER COMPANY
ELECTRIC MOTOR DIVISION
85 BROOK AVENUE, NORTH PLAINFIELD, N. J.

Please send me further information on Hoover Motors. I am particularly interested in motors for

_____
(indicate type of equipment)

Name _____

Company _____

Address _____

City _____ Zone _____ State _____

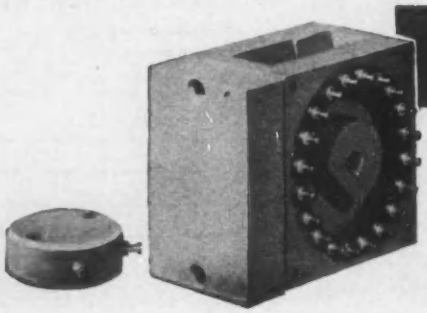
Here's why super-strong one-piece moldings of

PLASKON

"Shock resistance and dimensional stability are important factors in large circuit breaker housings"

—ITE CIRCUIT BREAKER CO.

These circuit breaker parts required complicated moldings with high impact resistance and dielectric strength. Plaskon Reinforced Alkyd gives clean, super-strong molded parts with superior electrical properties, high shock and fire resistance important to this navy-type circuit breaker.



"Dimensional stability of Reinforced Alkyd insures difficult press fit for bearing in commutator body"

—BENDIX PACIFIC DIVISION

This commutator body, molded of Plaskon Reinforced Alkyd, must provide a perfect fit for a bearing assembly. Reinforced Alkyd's high dimensional stability provided the answer; helped cut costs by eliminating difficult fabrication and reducing number of rejects.

REINFORCED ALKYD

are replacing costly, complex parts assemblies

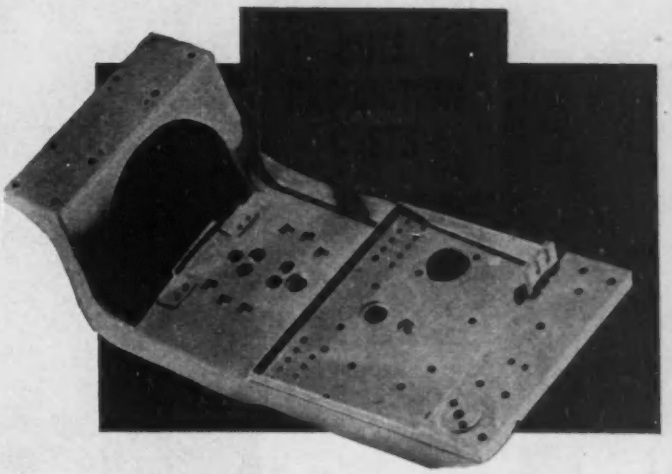
With increasing frequency, electronics manufacturers are turning to Plaskon Alkyd reinforced with glass fibers. They insist upon its rugged strength, its high arc resistance.

And they demand the lowered production cost which results when many individual parts and operations are consolidated through use of one-piece Plaskon Reinforced Alkyd moldings.

Manufacturers who have replaced other materials with Plaskon Reinforced Alkyd molding compound, credit it with the following advantages:—

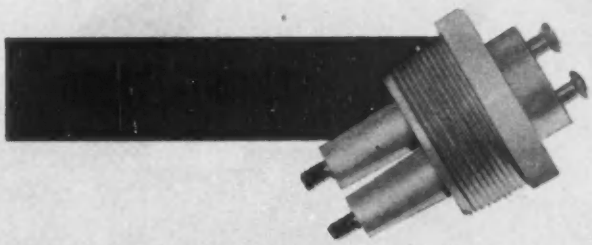
- **One-piece moldings reduce assembly and fabrication costs; also eliminate many drilling, grinding, tapping and other machining costs.**
- **Can be molded to close tolerances in complex shapes.**
- **Provides rigid and dimensionally stable setting for metal inserts, where required.**
- **Super-strong. Moldings retain high strength even in thin sections.**
- **Cures rapidly at moderate pressures.**
- **Molds readily on conventional equipment.**
- **High arc resistance.**
- **High dimensional stability.**
- **High heat and shock resistance.**

Why not consult with us on possible simplification and improvement of your product by using Reinforced Alkyd one-piece moldings in place of multiple parts assemblies—particularly if you require strong parts with excellent electrical insulating properties. Write, today, for complete information to Barrett Division, Dept. 6123



"Eliminated 140 production operations with Plaskon Alkyd"
—WESTINGHOUSE ELECTRIC CORPORATION

This centralized electrical control panel, molded of Plaskon Reinforced Alkyd, eliminated assembly of 140 separate parts. This complex panel must isolate electrical parts from each other; must withstand rough treatment in maintenance operations. Plaskon Alkyd, reinforced with glass fibers, provided the necessary high arc resistance, heat resistance and impact strength. The panel's "finished look" is a decided improvement.



"Two-inch threaded section, molded with ease, using Plaskon Reinforced Alkyd"
—B/W CONTROLLER CORPORATION

This one-piece electrode holder features a 2" threaded section transfer molded of Plaskon Alkyd reinforced with glass fibers. Clean molding characteristics plus superior electrical properties make Plaskon Reinforced Alkyd a natural choice for this application.

BARRETT DIVISION

ALLIED CHEMICAL & DYE CORPORATION
2112 SYLVAN AVENUE, TOLEDO 6, OHIO

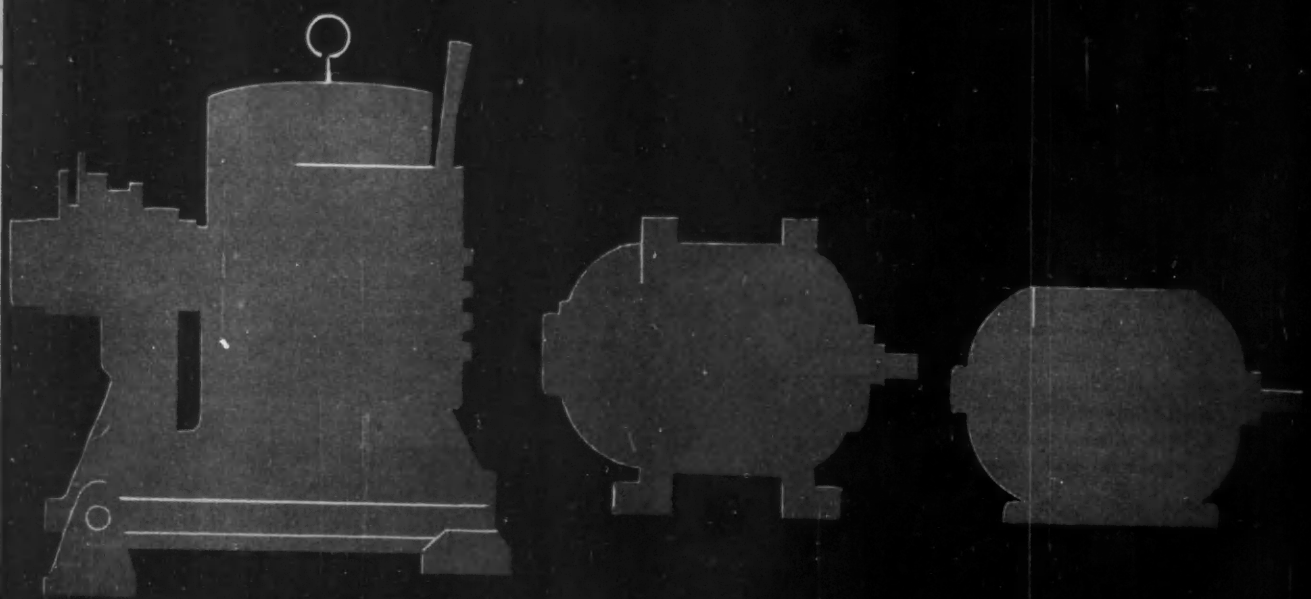
District Offices: Boston • Greensboro, N. C. Chicago • Cincinnati • Cleveland Detroit • Los Angeles • New York Philadelphia • St. Louis • Washington, D.C.

Manufacturers of Molding Compounds, Resin Glues, Coating Resins Paper and Foundry Resins Phenolic and Polyester Resins

In Canada:
The Barrett Company, Ltd. (Resins)
Canadian Industries, Ltd. (Molding Compounds)

PLASKON. Barrett
REINFORCED ALKYD

WHAT'S NEW IN MOTORS



1888
TESLA
5 H.P.
765 LBS.

1926
CS
5 H.P.
130 LBS.

1947
LIFE-LINE
5 H.P.
119 LBS.

IS STILL TO COME . . .

Hear anything about a new motor? Well, if you think you have, let's set the record straight . . . What's New In Motors Is Still To Come!

Westinghouse has been a leader in the designing and manufacturing of motors for over 60 years. During these many years, over 20 million dollars has been spent on the development of basic lines of induction motors to maintain this leadership. Here are the real years of "new motors" in the parade of progress:

1888—*THE FIRST A-C MOTOR—THE WESTINGHOUSE TESLA MOTOR*

1926—*THE FIRST SEALED SLEEVE BEARINGS—THE WESTINGHOUSE CS MOTOR*

1947—*THE FIRST MOTOR WITH PRE-LUBRICATED BEARINGS PLUS A ½ WEIGHT AND SIZE REDUCTION—THE WESTINGHOUSE LIFE-LINE MOTOR*

The smaller, lighter Westinghouse Life-Line Motor of 1947 was the last major contribution. *AND FOR THE NEXT ALL-IMPORTANT STEP AHEAD IN MOTOR PROGRESS . . . LOOK TO WESTINGHOUSE.*

YOU CAN BE SURE.. IF IT'S Westinghouse

J-21834

TROUBLE-FREE PHOSPHATIZING
with Pennsalt's outstanding NEW

FOSBOND

A COMPLETE SYSTEM—EVEN INCLUDING A DYNAMIC MERCHANDISING PLAN!

If phosphatizing has been a headache in your plant, here's the news you've been waiting for! Now Pennsalt, long a leader in the metal processing field, offers everything you need for uniform, trouble-free phosphatizing—for better, longer-lasting finishes.

The Fosbond Process comprises various Pennsalt-made chemicals for all operations from cleaning, pickling, and phosphatizing, through rinsing. They have been engineered to provide an excellent pre-paint corrosion-resistant surface while offering simplified operation through an entire balanced cycle. Major finish manufacturers have approved Fosbond for use wherever phosphate coatings are required under organic finishes.

Sound Technical Assistance

To help Fosbond users initiate and maintain this Process, Pennsalt offers technical assistance—on a regular, scheduled basis—from qualified, experienced specialists. These men will get the Process running smoothly on your operation and help you keep it that way.

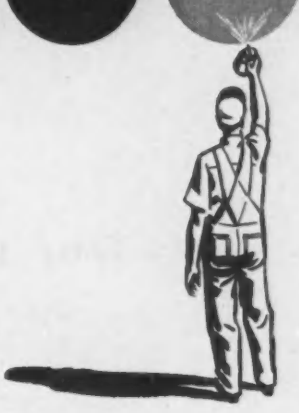
But that's not all! Fosbond has qualified for the famous *Good Housekeeping Guaranty Seal*, which has been incorporated into the colorful Fosbond emblem (see illustration). To gain wide public acceptance, this new merchandising symbol is being advertised in *Good Housekeeping*, *The Saturday Evening Post*, and other publications. Authorized manufacturers may affix this emblem to their Fosbonded products—thus gaining a valuable sales "extra."

Ask us to prove it!

So you can see actual Fosbond test panels for yourself, we will send you either Fosbond chemicals with which you can prepare panels, or panels prepared in our laboratories which you can then test. You be the judge! Just tell us 1) type metal to be phosphatized, 2) phosphate coating now used, 3) method of application, 4) organic finish used, 5) standards finish must meet.

Or, give us details about your operation, and we shall gladly answer questions about Fosbond as specifically as possible. Write: Metal Processing Dept., 463 Widener Bldg., Philadelphia 7, Pa.

PROCESS



A COMPLETE SET OF COMPOUNDS

for cleaning, pickling, phosphatizing, and rinsing. All from one reliable source—Pennsalt

APPLIED IN A BALANCED CYCLE...

tailor-made by Pennsalt engineers to fit your operations and equipment

SERVICED AND MAINTAINED...

by experienced field servicemen on a regular, scheduled basis

ADVERTISED AND MERCHANDISED

to help pre-sell your quality finish to wholesalers, dealers, and consumers

At Pennsalt's famous Whitemarsh Research Laboratories, where Fosbond was developed, there are unusually fine testing facilities at the disposal of manufacturers using the Process.

FOSBOND IS A PENNSALT TRADEMARK

A better start for your finish

Pennsalt Chemicals

PENNSYLVANIA SALT MANUFACTURING COMPANY

When SCHATZ can save you up to 6 to 1

Why pay for unneeded precision in ball bearings?

In many applications where speeds and loads are moderate, you don't need a precision bearing. When this is the case, Schatz "Commercial" Ball Bearings can cut your costs by as much as 85%—*without any sacrifice in operating efficiency.*

Why are savings like this possible? Because "Commercial" Ball Bearings are designed to wider tolerances than precision bearings...because they are available unground, partially-ground, or fully-ground. And, because, in almost all cases, cages are not used.

If you have an application where speeds and loads are moderate, it will pay you to look into Schatz "Commercial" Ball Bearings. To learn how you may save, write for literature described below.

THE SCHATZ MANUFACTURING COMPANY
6758 Fairview Avenue, Poughkeepsie, New York

Schatz "Commercial" Bearings used on these products

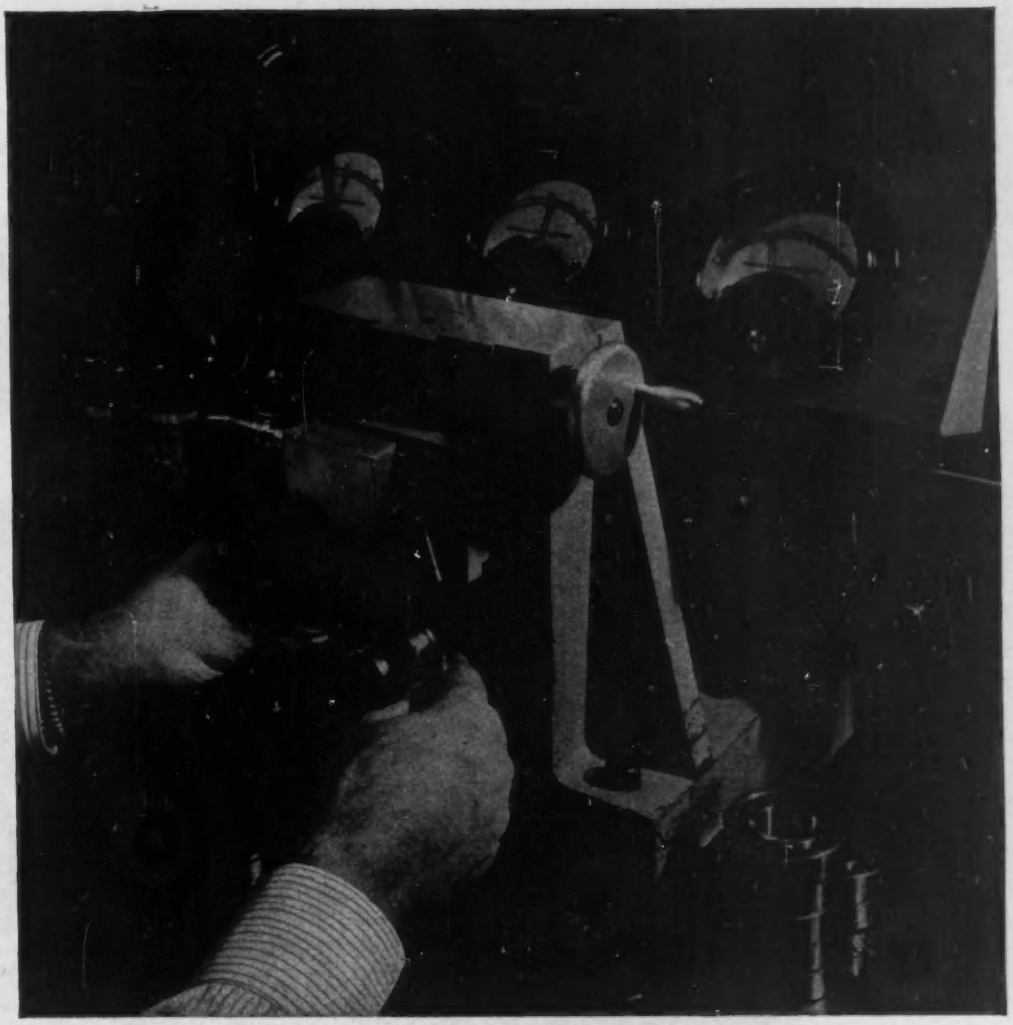
Dishwashers • Outboard motors
Automobile steering mechanisms
Elevators • Box machinery
Office equipment
Flexible shafts • Lawn mowers
Masonry cutting equipment
Textile machinery • Farm equipment
Laundry equipment

What about your product?

The oldest, largest manufacturer of "Commercial" ball bearings

SCHATZ "Commercial" BALL BEARINGS

Technical literature available:
Schatz Catalog 11 contains drawings and specifications of Schatz Ball Bearings.
Technical Bulletin tells how to determine proper type and size "Commercial" Ball Bearing for various speeds and loads.
Nylon Bearing Parts discusses advantages of nylon parts in "Commercial" bearings.



He listens by looking...

And why not? It takes the guesswork out of test work.

QUIET BALL BEARINGS are longer running, smoother running, and stand up better under heavy loads.

That's why Federal inspectors rely on their eyes rather than their ears when testing the sound of a bearing. They use an Anderometer, a highly sensitive machine which picks up a bearing's slightest whisper and translates it into electrical impulses. By glancing at the dial indications, the inspector can easily tell if the bearing measures up to Federal standards.

This "listening by looking" is but one of the many tests that guarantee top-notch performance from *every* Federal Ball Bearing.

The Federal Bearings Co., Inc., Poughkeepsie, N. Y.

Federal

Ball Bearings

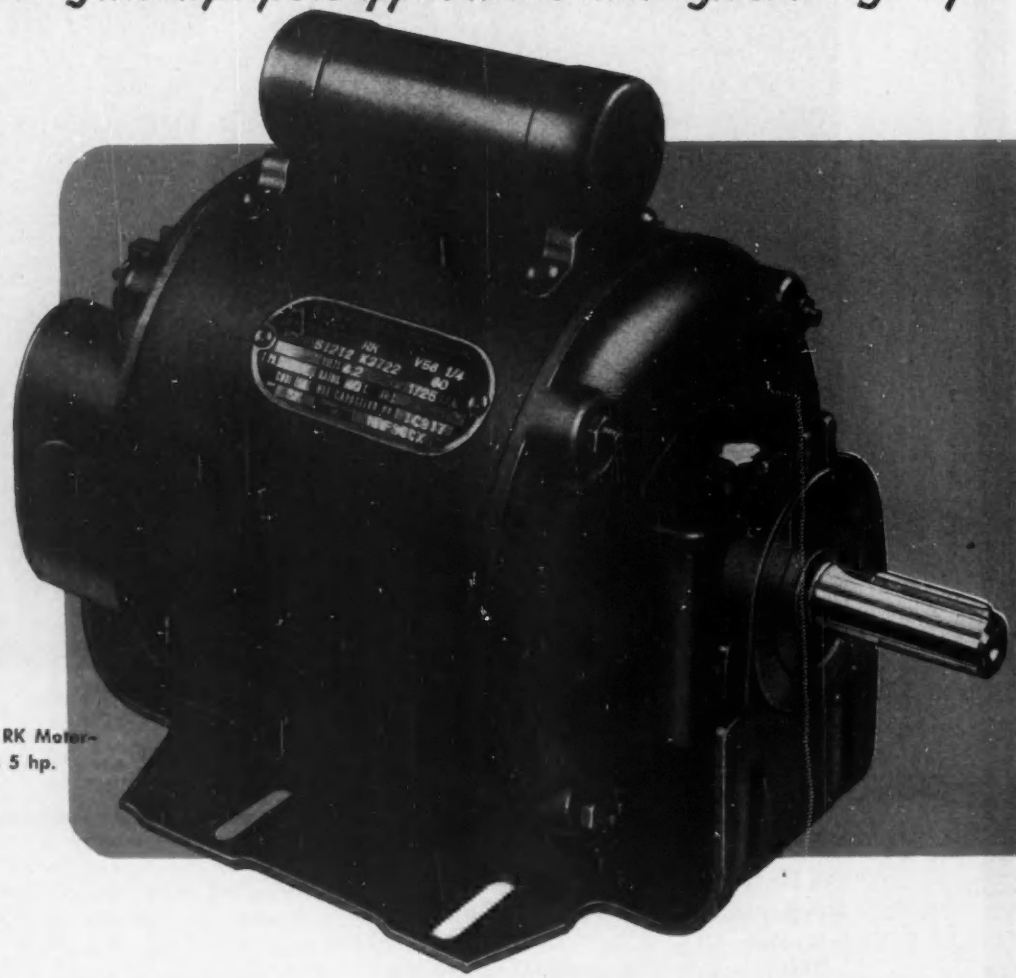
One of America's Leading Ball Bearing Manufacturers

Wagner
ELECTRIC MOTORS
...the choice of leaders in Industry

Wagner

CAPACITOR-START MOTORS

for general purpose applications with high starting torque



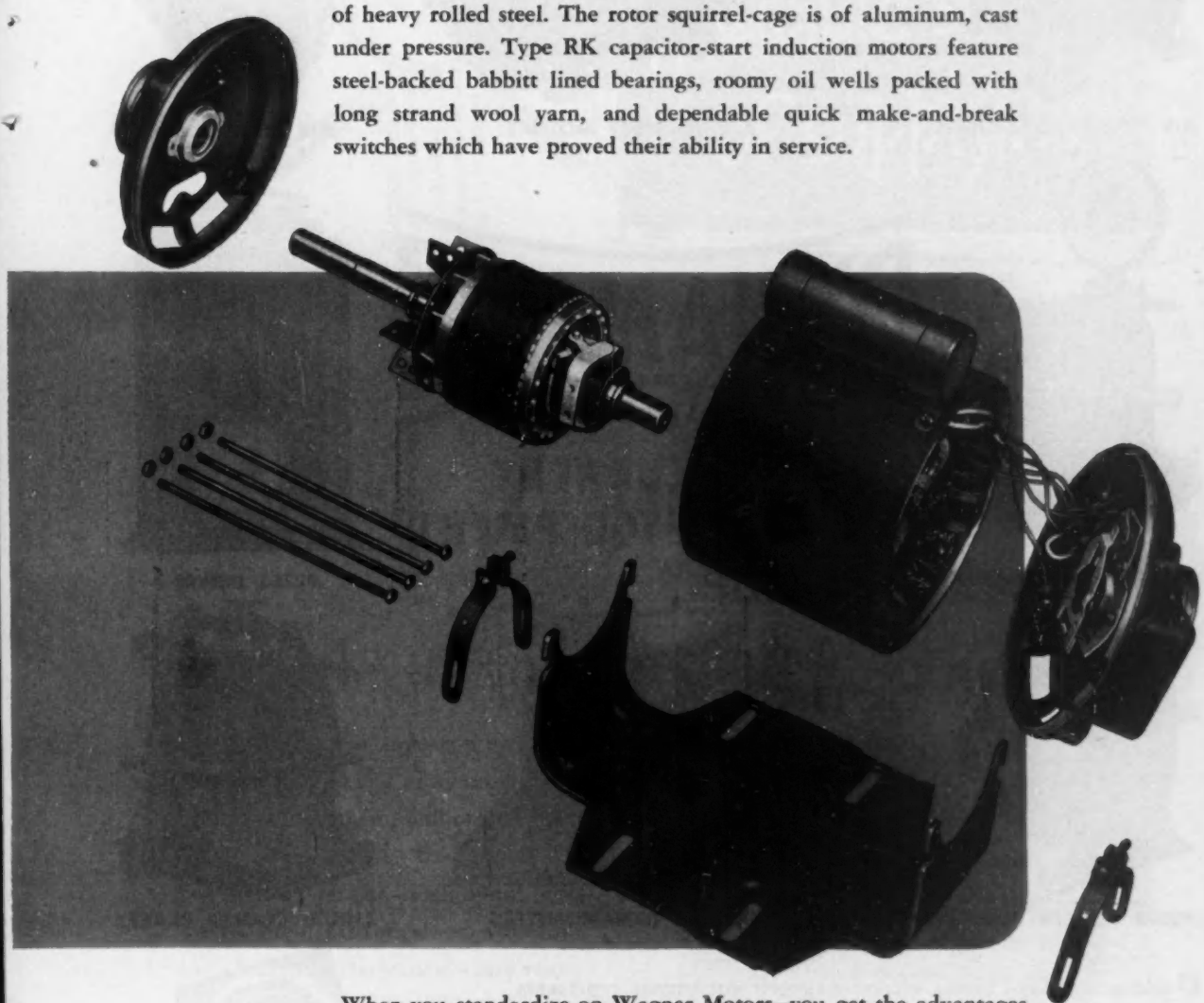
Type RK Motor—
1/6 to 5 hp.

Wagner capacitor-start induction motors are a sound choice for applications where starting loads are fairly heavy, but which can be brought up to operating speed quickly. They have become increasingly popular for installation on equipment such as air conditioners, refrigerators, freezers, water pumps, motor-driven tools, and on similar fractional or integral horsepower applications.

These motors offer low maintenance cost—only a minimum of servicing is required—and they give many years of reliable service with unusual freedom from vibration and noise.

M53-12

These motors are available in frames 225 and smaller, in open or totally-enclosed types—sleeve or ball bearing, with rigid or resilient bases or machined endplates for flange mounting. Frames are formed of heavy rolled steel. The rotor squirrel-cage is of aluminum, cast under pressure. Type RK capacitor-start induction motors feature steel-backed babbitt lined bearings, roomy oil wells packed with long strand wool yarn, and dependable quick make-and-break switches which have proved their ability in service.



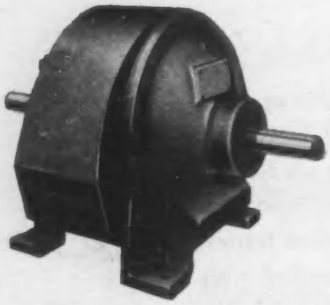
When you standardize on Wagner Motors—you get the advantages of a liberal warranty . . . of nationwide service facilities, with on-the-spot service, replacement motors and parts available from 25 Wagner-owned Service Branches and more than 750 Authorized Service Stations. You can choose from a wide variety of types and sizes—single-phase or polyphase—(from 1/125 to 400 hp). Bulletin MU-185 gives complete information—write for your copy.

Wagner Electric Corporation
EST. 1891

WAGNER ELECTRIC CORPORATION
6406 Plymouth Avenue • St. Louis 14, Mo., U. S. A.

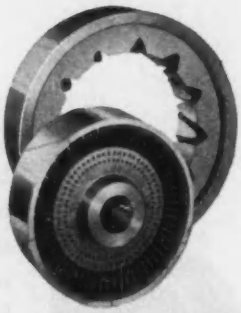
ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

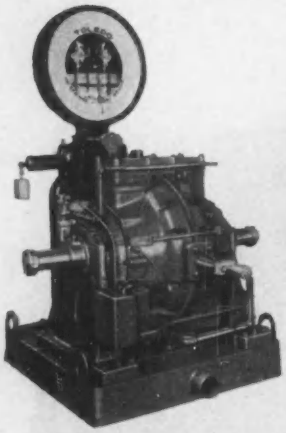


AIR COOLED COUPLINGS

AJUSTO-SPEDE MOTORS



AIR COOLED BRAKES

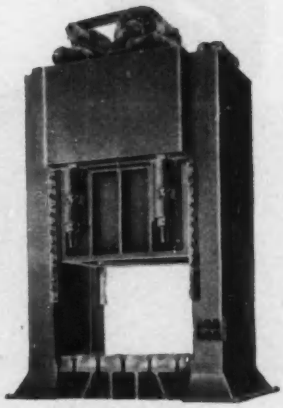


ABSORPTION DYNAMOMETERS

EATON

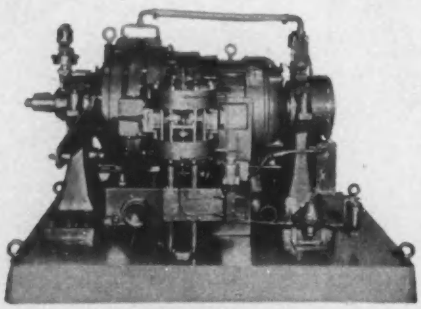
DYNAMATIC

EDDY-CURRENT ROTATING EQUIPMENT



PRESS DRIVES

LIQUID COOLED COUPLINGS



UNIVERSAL DYNAMOMETERS

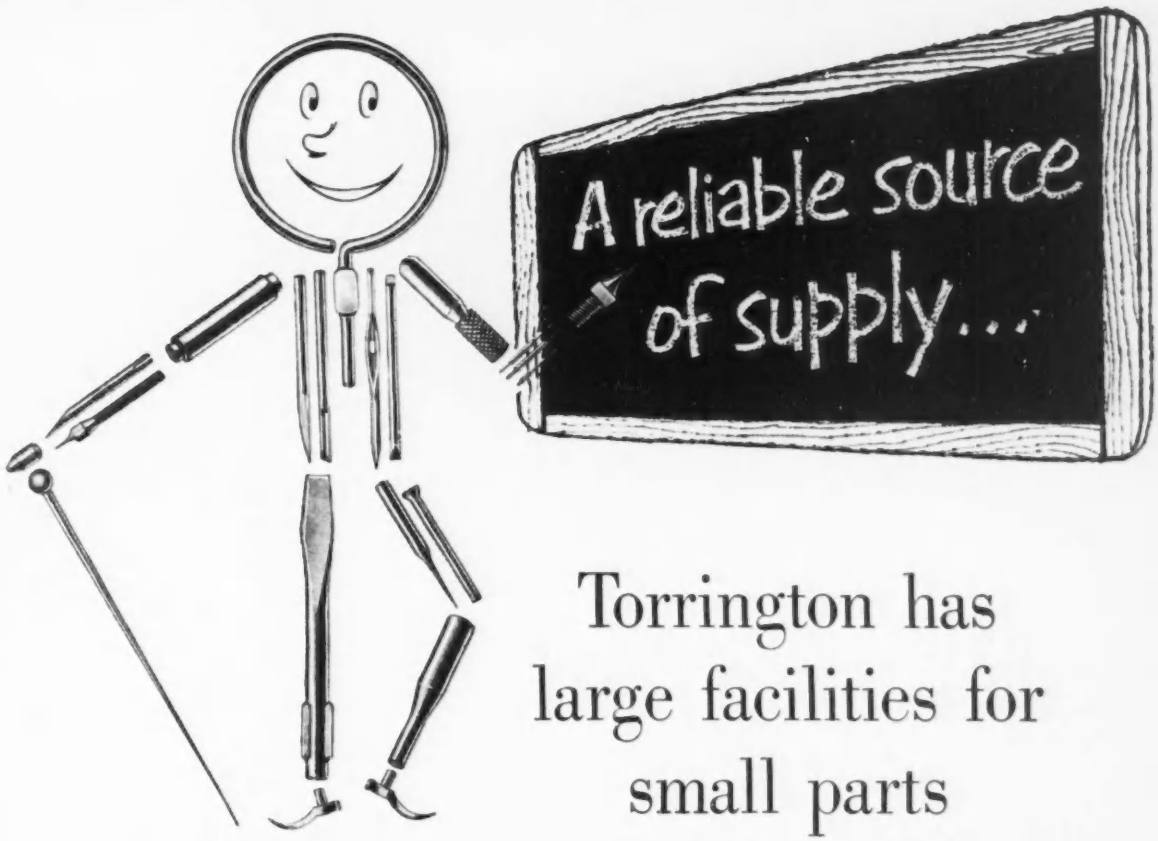
LIQUID COOLED BRAKES

Dynamatic Eddy-Current electro-magnetic equipment represents the ideal solution for a wide range of adjustable-speed drive problems, particularly where an AC power source is a requirement. Typical applications include paper machine drives, cement mill drives, industrial truck clutches, press drives, crane brakes, fan drives—in fact, practically all test, processing, and conveying equipment common to industry. Instantaneous response and accurate control are important advantages.

Write for your copy of Bulletin GB-1 which describes and illustrates the basic Dynamatic units.

DYNAMATIC CORPORATION KENOSHA • WISCONSIN

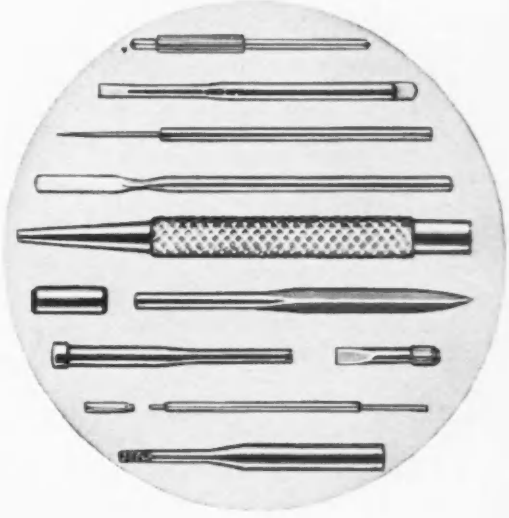
Subsidiary of EATON MANUFACTURING COMPANY, Cleveland, Ohio



Torrington has large facilities for small parts ...made to your exacting standards!

Eighty-six years of precision metal working know-how . . . special automatic machinery capable of producing millions of precision pieces a day . . . that's the kind of service Torrington offers on small metal parts.

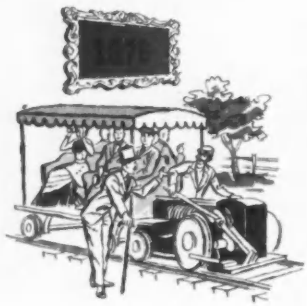
Pins, pivots, mandrels, special drills and blades, shafts, punches and many others . . . the Standard Plant, home of the Specialties Division, can make them in any metal, better, faster, and *for less* than you can. Send your blueprints or a sample part for a prompt quotation.

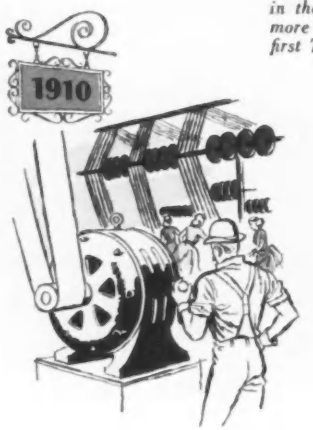


This Condensed Catalog Can Save You Money! This catalog of small precision metal parts shows some of the types and sizes that can be produced by Torrington quickly and economically. Send for your copy today.

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.

Makers of
TORRINGTON NEEDLE BEARINGS





***1878:** Thomas Edison builds an electric motor for his Menlo Park "Express."... **1910:** G.E. establishes motor leadership in the infant electric industry.... **1925:** G.E. adds 4 times more power per pound as it develops newer models.... **1939:** first Tri-Clad motor sets 14-year standard.*

General Electric Announces...

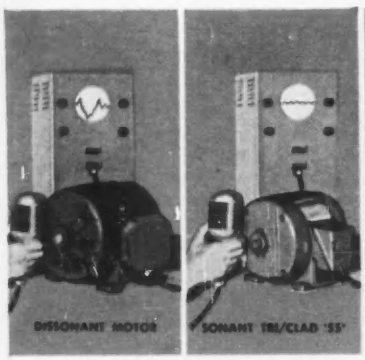
A NEW MILESTONE IN MOTOR HISTORY

New TRI 55 CLAD motor climaxes 75 years of engineering leadership

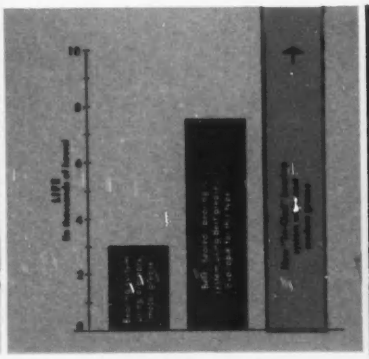
The General Electric Tri/Clad '55' is an important milestone in motor history. For this is a *completely new motor*. Born out of thousands of engineering man-hours, the Tri/Clad '55' incorporates design improvements that go far beyond mere modifications. Many years of pure research, the discovery of new, better materials, the knowledge of how to make better use of present materials, and improved manufacturing processes all make the Tri/Clad '55' motor the new leader in the motor field.

You as a motor user should take the opportunity to see and test this motor for yourself. Contact your nearest G.E. Apparatus Sales Office or G.E. Motor Agent and tell him you want to see the new G-E Tri/Clad '55'. General Electric Company, Schenectady 5, N. Y.

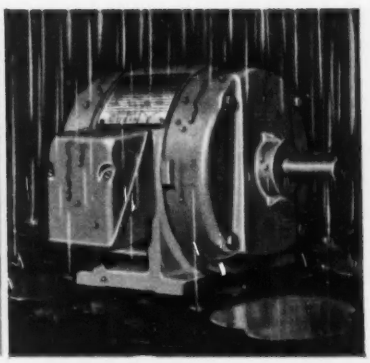
648-4



DESIGNED FOR BETTER PERFORMANCE: Tri/Clad '55' has a low noise level . . . runs cool . . . gives up to 53% increase in shaft output per pound...has higher full-load speeds.



ENGINEERED FOR LESS MAINTENANCE: 10%-life tests (such as the one shown) prove the Tri/Clad '55' bearings last longer without regreasing than any other bearing system.



BUILT TO LAST LONGER: cast-iron strength . . . more fully enclosed dripproof construction . . . water-shedding stator windings . . . polyester film insulation 8 times stronger.

GENERAL ELECTRIC
TRI-CLAD INDUCTION MOTOR
MODEL
SER NO.
HP
FL RPM
VOLTS
PHASE
CYCLES
FL AMP
TYPE
FRAME
TIME RATING
C RISE
CODE
TRI-CLAD
THE LEADER IN MODERN MOTOR DESIGN
Progress is our most important product
GENERAL ELECTRIC

See what adhesives are doing today!

Photo Courtesy of Jefferson Electric Company

Keeping a secret—*on time*

Here, perhaps, is the most talked about clock of our time. It's the *Golden Hour* Electric Clock—a timepiece of mystery because its hands seem to keep time without the aid of moving parts.

Actually, the secret of its operation is 3M's! A 3M adhesive, EC-847, is used to secure the face of the clock to a stainless steel timing rim in the clock ring. This rim is geared to mesh with and turn the entire glass face, which in turn operates its intricate hand assembly.

In a mechanism such as this, you can readily appreciate the importance of a dependable bond between glass (clock face) and steel (motor gear). The very accuracy of the timepiece depends on it.

See what adhesives can do for you...

see our catalog in PRODUCT DESIGN FILE or write for copy

Although this use of a 3M adhesive is shrouded in mystery, there are thousands of others that are not. For full details, call in your 3M sales engineer, or write for a free booklet. Address: 3M, Dept. 412, 417 Piquette Ave., Detroit 2, Michigan.

3M COMPANY

ADHESIVES•COATINGS•SEALERS

MINNESOTA MINING AND MANUFACTURING COMPANY

ADHESIVES AND COATINGS DIVISION • 417 PIQUETTE AVENUE, DETROIT 2, MICHIGAN

GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N.Y. 17, N.Y. • CANADA: LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

Gets greater accuracy in heavy duty threading... *with spindle on TIMKEN® bearings*

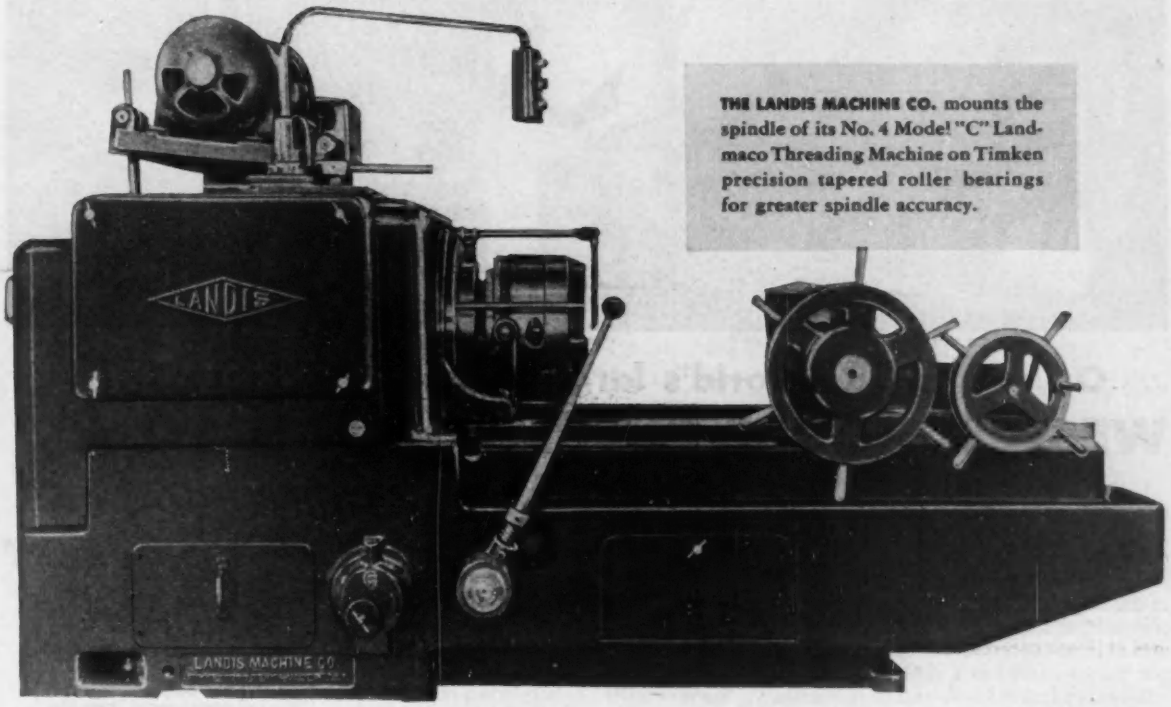
THE Landis Machine Company designed their No. 4 Model "C" Landmaco Threading Machine for heavy duty precision threading on large diameter work. To make sure it delivers that precision, Landis engineers mount the spindle on Timken® precision tapered roller bearings.

Designed for spindle applications, these Timken bearings maintain spindle precision and accurate gear mesh no matter how heavy the load. Timken roller bearings are tapered in construction to take radial, thrust and combination loads. Line contact between rollers and races provides maximum capacity. Shafts are held in rigid alignment. Proper gear meshing is assured. Shaft wear is eliminated, gear wear reduced.

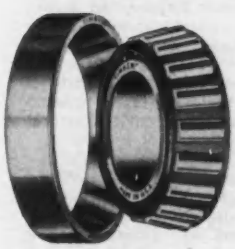
Timken bearings normally last the life of the machine because they're engineered for the job, precision manufactured and made of special analysis Timken fine alloy steel.

For over 25 years, Timken bearings have contributed to the development of precision machine tools. Be sure you have them in the machine tools you build or buy. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

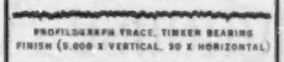


THE LANDIS MACHINE CO. mounts the spindle of its No. 4 Model "C" Landmaco Threading Machine on Timken precision tapered roller bearings for greater spindle accuracy.



TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 50 X HORIZONTAL)



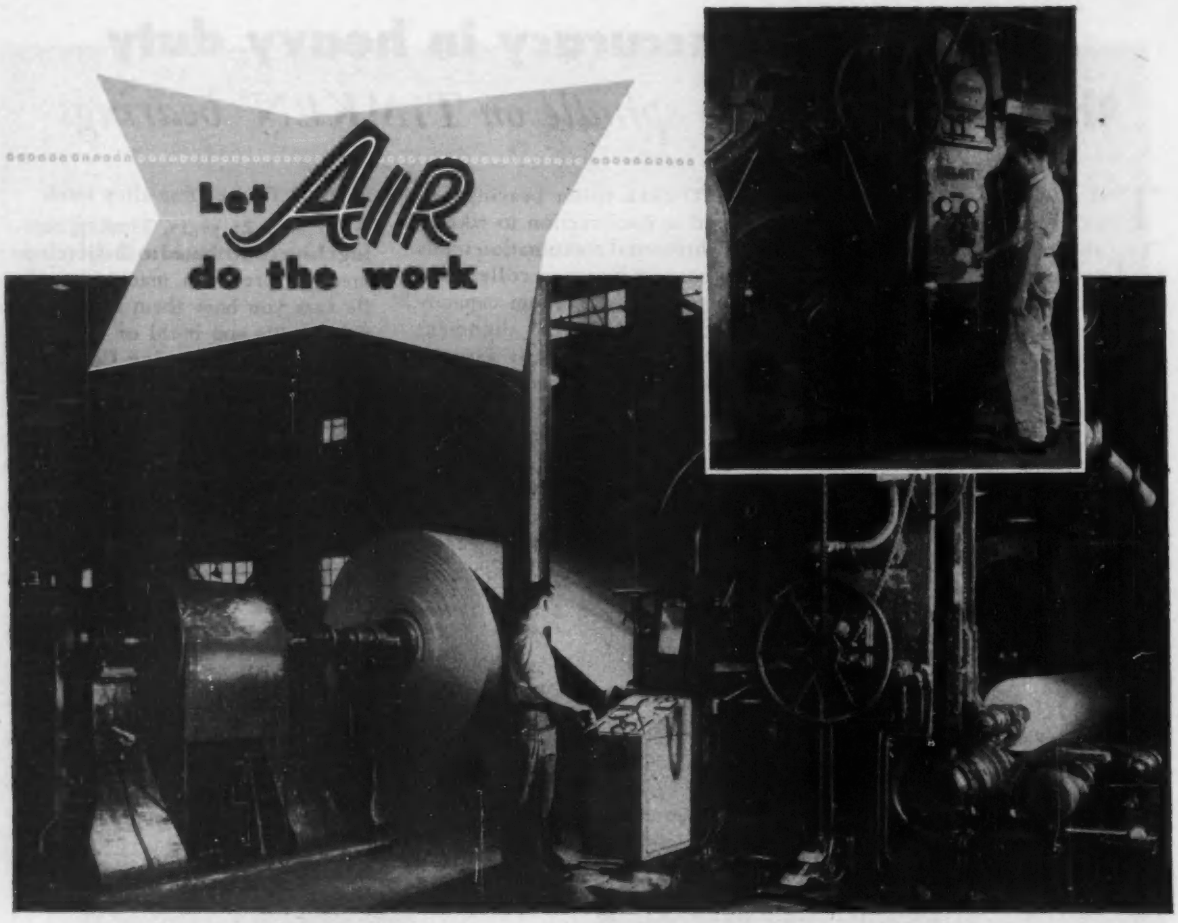
PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5,000 X VERTICAL, 50 X HORIZONTAL)

OPTICAL FLAT, PERFECT FINISH

SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

NOT JUST A BALL — NOT JUST A ROLLER — THE TIMKEN TAPERED ROLLER — BEARING TAKES RADIAL AND THRUST — LOADS OR ANY COMBINATION



On one of the world's largest paper machines...

WESTINGHOUSE PNEUMATIC CONTROLS

provide *smooth* starting and stopping

THE big Macon, Ga. paper mill of Macon Kraft Co. is equipped with one of the largest Fourdrinier-type paper machines in the world. This machine operates at linear speeds from 850 to 1550 ft. per minute and has a daily capacity of 550 tons of heavy krafts and liner boards. Westinghouse Air Brake pneumatic control valves are used on this machine wherever gradual, smooth stopping and starting are required.

The entire Fourdrinier wire section, the 102 10-ton dryer rolls, and the rewinder splitter that handles rolls of paper weighing up to 14 tons, are all controlled with Westinghouse valves. The accurate, cushioned control provided by these valves reduces starting and stopping shocks imposed on the big power transmission units . . . cuts down maintenance and repairs . . . and increases the useful life of this expensive machine. As new valves are needed in other sections of the machine, Macon Kraft Co. plans to install more Westinghouse valves where closely controlled pressures are required.

FREE TECHNICAL ASSISTANCE

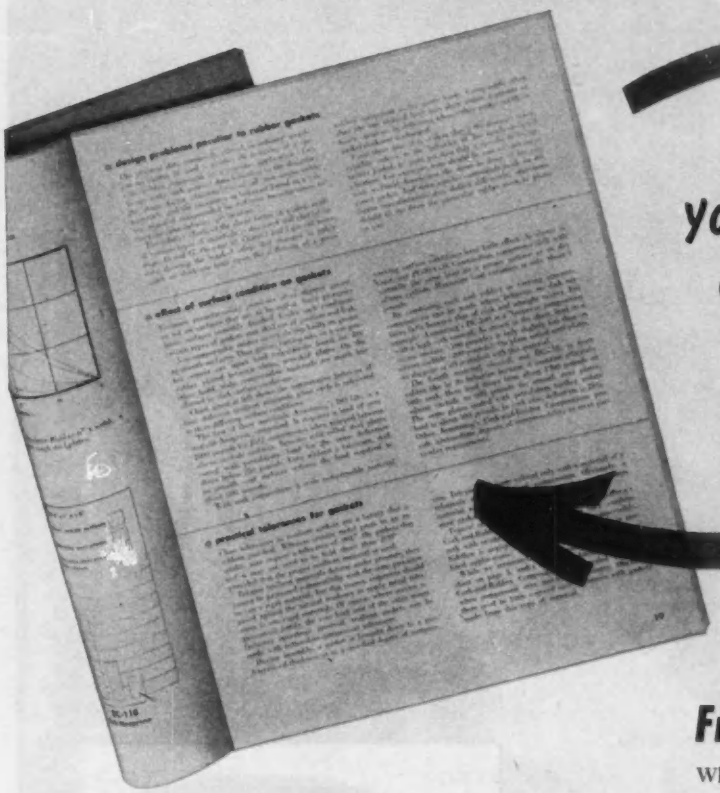
We can help *you* design a complete control system to provide more automatic operation, reduce operator fatigue, cut down wear and tear on your machine . . . all at relatively low cost. Our control and reducing valves, cylinders, actuators, checks, cocks, and other devices assure you years of *reliable* operation. For complete information write to Westinghouse Air Brake Co., Industrial Products Division, Wilmerding, Pa.

Westinghouse Air Brake COMPANY

INDUSTRIAL PRODUCTS DIVISION WILMERDING, PENNSYLVANIA

FACTORY BRANCH: EMERYVILLE, CALIF. IN CANADA: CANADIAN WESTINGHOUSE CO., LTD., HAMILTON, ONTARIO

What tolerances are practical for resilient gasket materials?



You'll find the answer in this new 24-page gasket manual

17 helpful sections, including:

- DESIGNING FLANGES FOR EFFICIENT SEALING
- SEALING WITH CONFINED RESILIENT GASKETS
- DESIGNING GASKETS TO REDUCE COSTS
- EFFECT OF GASKET WIDTH ON COMPRESSION
- RELATION OF GASKET THICKNESS TO LOAD
- DESIGN PROBLEMS PECULIAR TO RUBBER GASKETS
- EFFECT OF SURFACE CONDITIONS ON GASKETS

Free for your files

When you need to know the right tolerance for a cork-and-rubber gasket, or the current SAE-ASTM specifications for gaskets, you can find the up-to-date answer in your free copy of "Armstrong's Gasket Materials." Just revised for 1953-54, Armstrong's new 24-page manual is a must for everyone concerned with gaskets or their design. It contains full information on the various gasket materials, latest U. S. Government and SAE-ASTM specs, plus useful data on gasket, flange, and joint design. For a free copy, mail the coupon below.

Send coupon today

ARMSTRONG'S GASKET MATERIALS

Armstrong Cork Co., Industrial Div.,
7112 Irvin Street, Lancaster, Penna.

Please send me your new 24-page gasket manual.

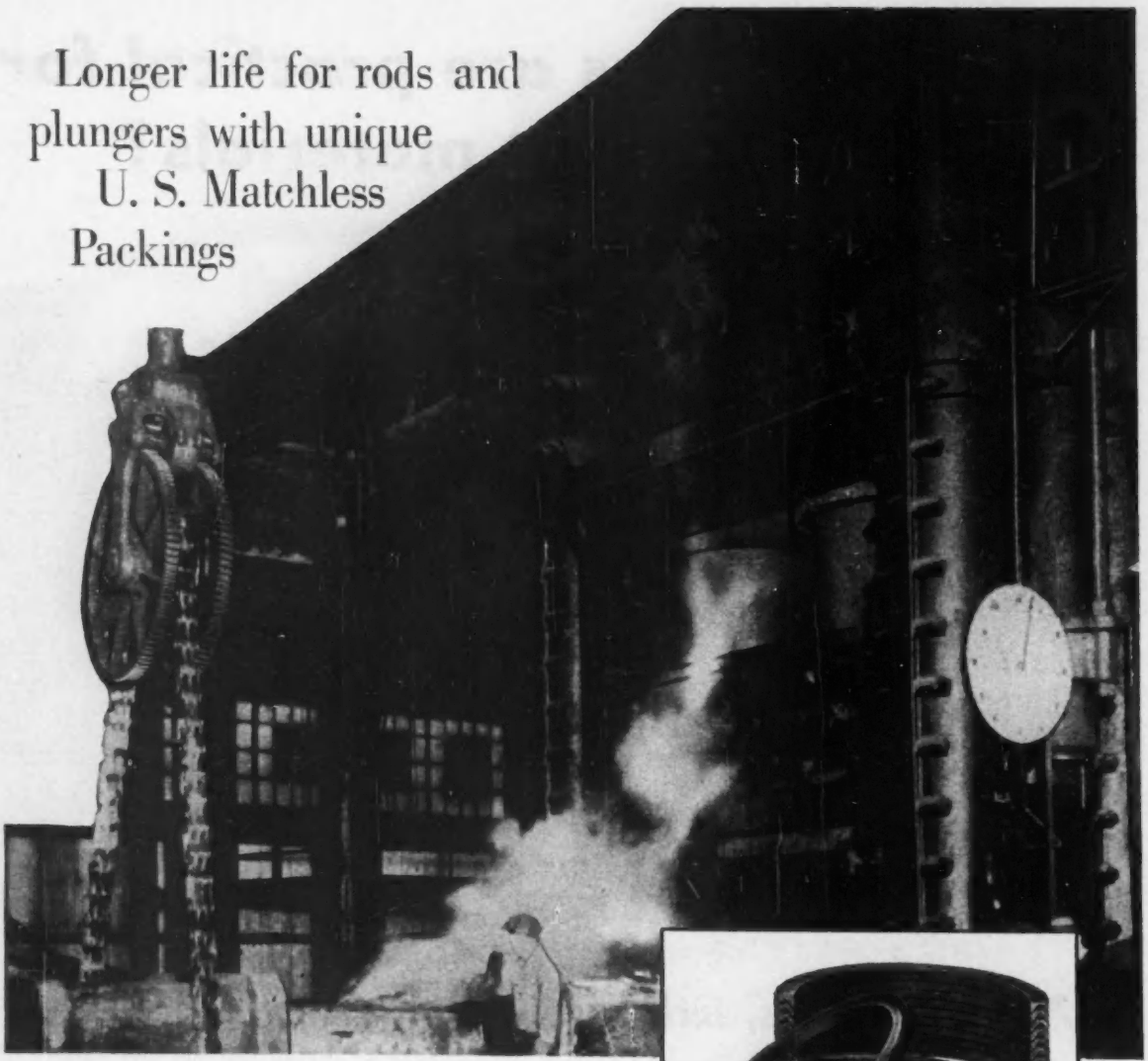
Name _____

Company _____

Address _____

_____ *Position* _____

Longer life for rods and plungers with unique U. S. Matchless Packings



U. S. Matchless Packing comes in 12 different styles, to handle pressures up to 8,000 lbs. per square inch.

No other packing has *all* these advantages:

- **Blunt edges**—provide uniform strength throughout.
- **Triangular spaces**—to trap loose scale, oil.
- **Pressure break**—provides faster, more effective action.
- **Molded end rings**—no sharp edges to break off.
- **Easy to install**—because of parallel (not flare type) side walls.

Matchless® Packing reduces wear and tear on rods and plungers, minimizes friction because it has a self-adjusting, automatic action. Designed for hydraulic equipment, presses, rams, triplex pumps and outside packed pumps. This *quality* U. S. Matchless Packing is stocked at any of the 25 "U. S." District Sales Offices—each staffed with engineers—and distributed by wholesalers everywhere. Or write to address below.

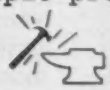
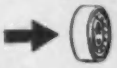
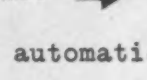
U.S. RUBBER
SERVING THROUGH SCIENCE

"U.S." Research perfects it
"U.S." Production builds it
U.S. Industry depends on it

UNITED STATES RUBBER COMPANY

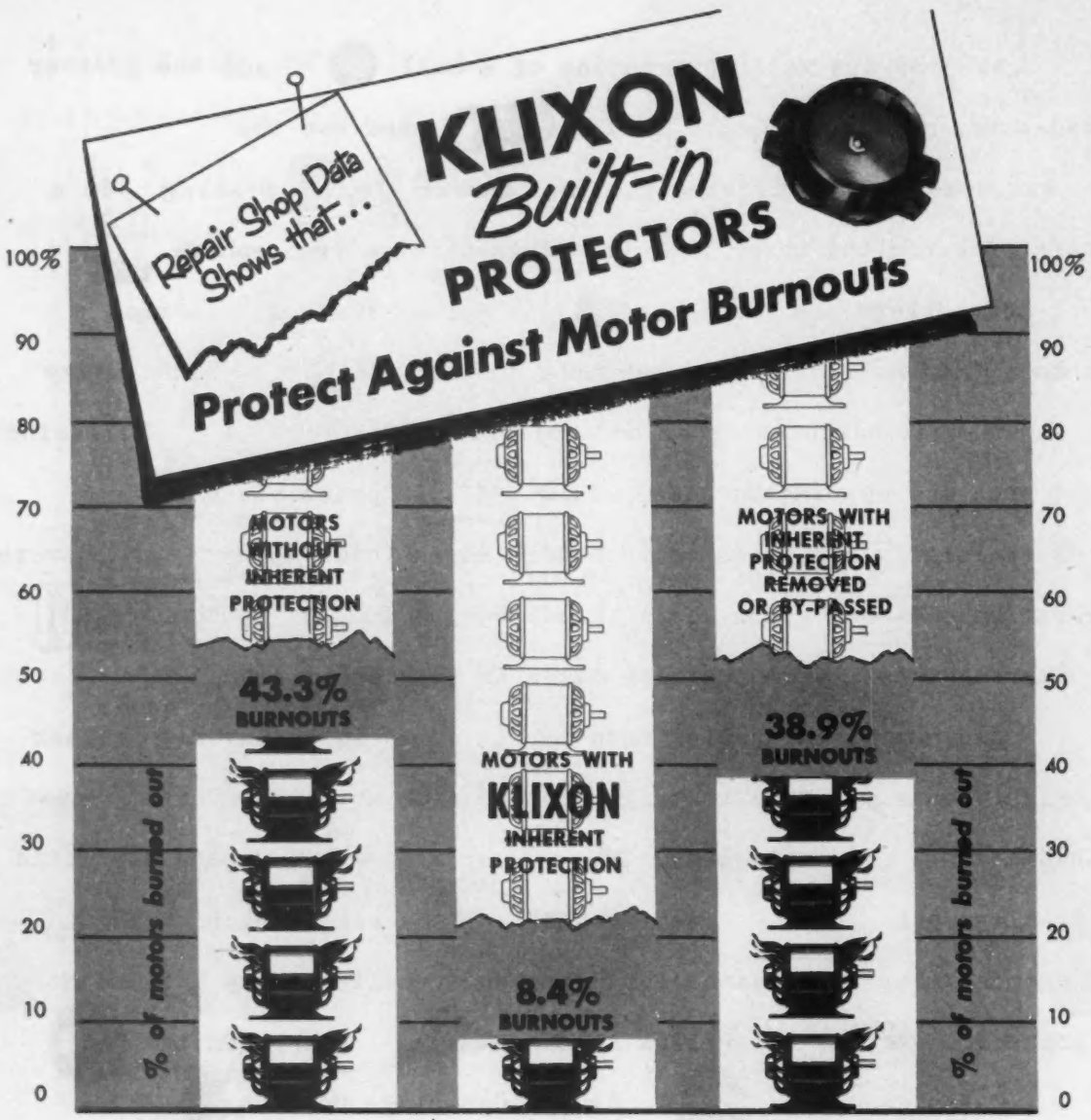
MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

Take the low rolling friction of a ball add the greater load-carrying capacity of a roller and see the basic advantages offered you in a Shafer CONCAVEX Bearing. In a Shafer Bearing the inner race is a segment of a true sphere and rollers are concave Normal loads are carried on more than half of the center area contact Under heavy loads case-hardened races and rollers compress increasing load area and bearing surface. This CONCAVEX principle provides exceptionally high reserve to handle shock loads  and severe vibration How about thrust  loads? In the CONCAVEX Bearing these loads are also taken in the center area and not at the roller ends as in the average roller bearing. Thus you have the right combination to handle Thrust  Radial or Angular or all Add automatic self-alignment positive "Z" seals, Micro-Lock adjustment that compensates for wear, and you'll see why all industry looks for SHAFER on Pillow Blocks Flange Units Cartridge Units Flange Cartridge Units Take-up Units Duplex Units Take-up and Frame Units and Self-Contained Bearings Call or write Shafer Bearing Division of Chain Belt Company, 801 Burlington Ave., Downers Grove, Illinois.

leading Bearing Design for more than 33 years!

SHAFER
BEARING DIVISION OF
CHAIN BELT COMPANY



43.3% of motors without built-in protection were burned out. These motors had overcurrent protection mounted away from the motor — See National Electrical Code, Article 430, Sections 4321, 4322, 4323.

8.4% of the motors with KLIXON Built-in Protection were burned out.

38.9% of motors with a shorted out or removed built-in protector were burned out.

Here are the facts — Recent surveys of repaired fractional h.p. motors were conducted in motor repair shops.

The motors were in these shops for repairs because of burned out windings, worn parts, etc. These surveys show that the percentage of motor burnouts is very small among KLIXON built-in protected motors. (See the graphs above.)

Note also, that among motors with the built-in protector removed or shorted out, the burnout percentages were very high as would be expected because these motors were no longer inherently protected.

Get the most out of your motors and motor driven equipment. Specify "built-in Klixon Protectors" with every motor you buy. The additional cost is exceptionally low . . . pays off in fewer motor burnouts, less repairs and replacements.

SPENCER THERMOSTAT
Division of Metals & Controls Corporation
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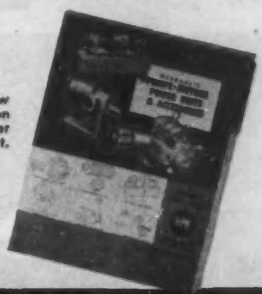

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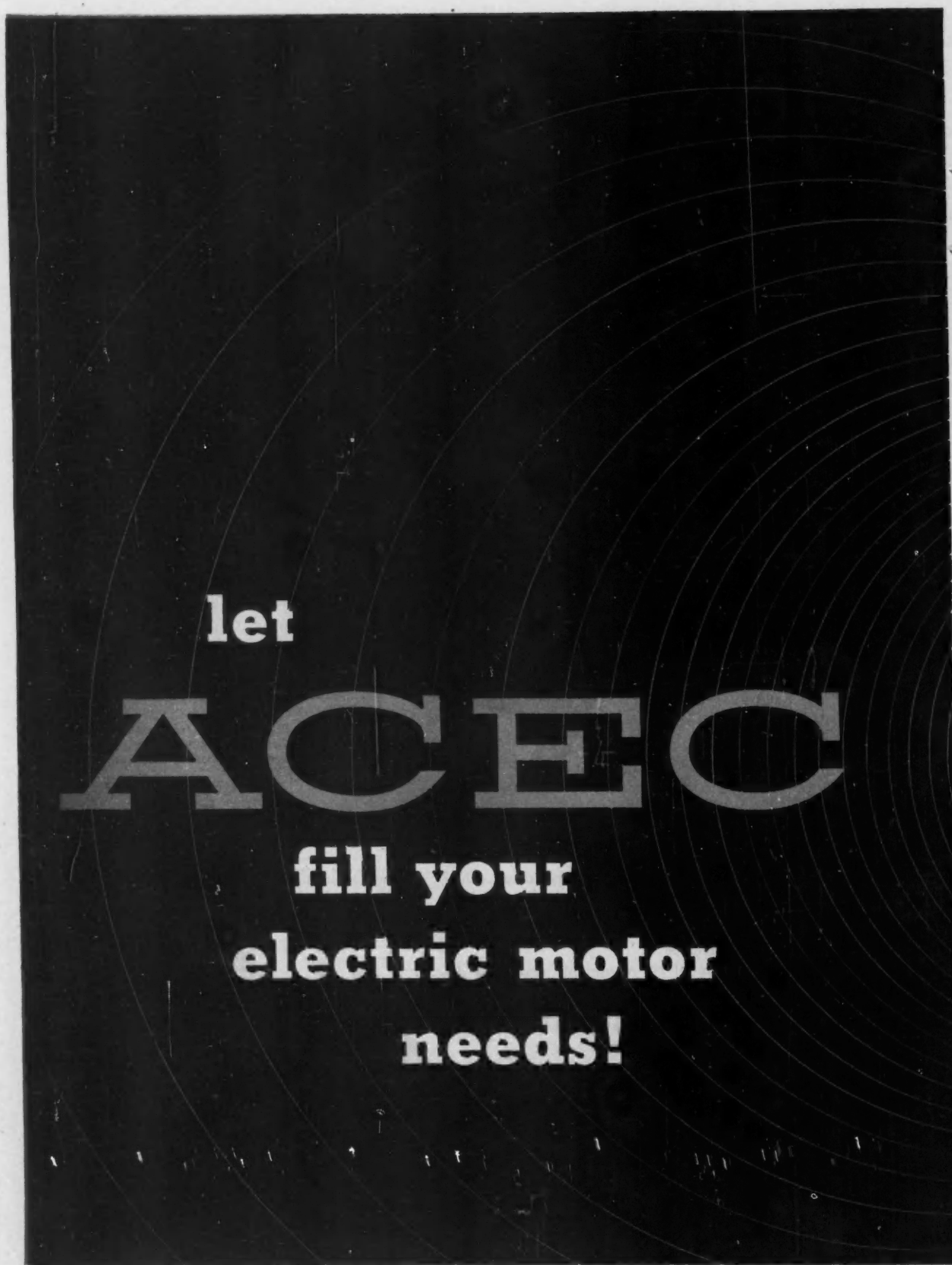

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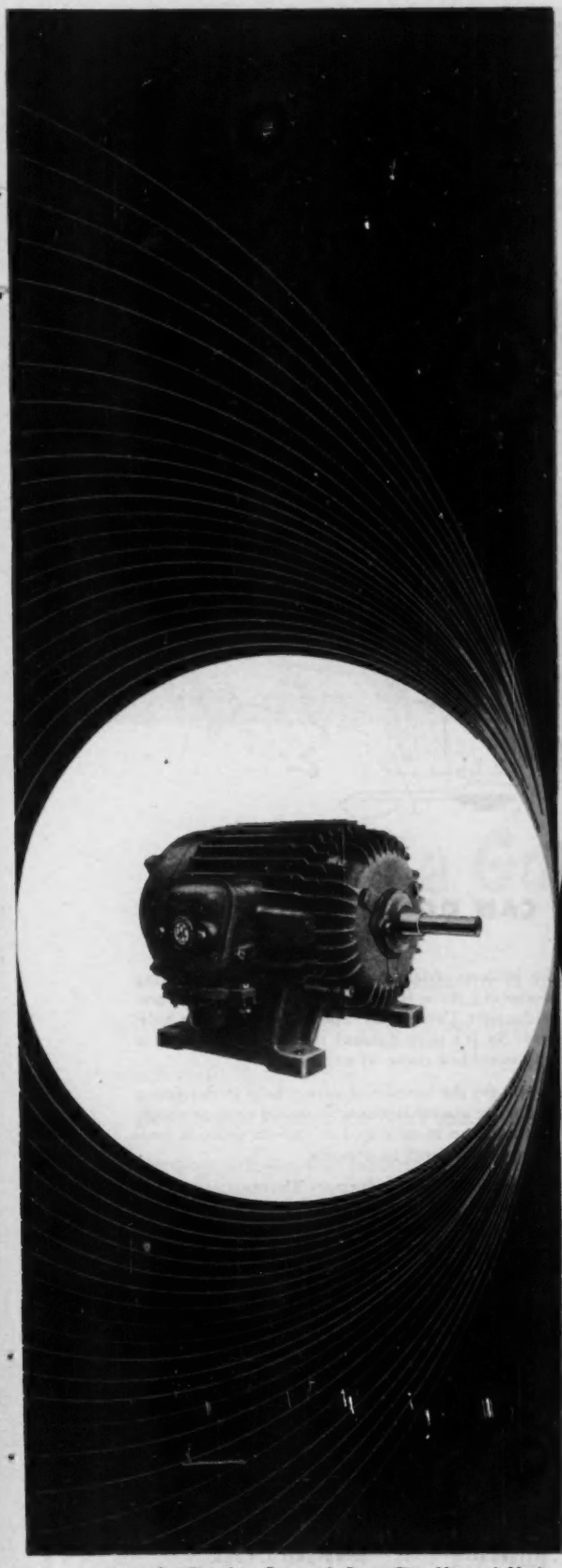

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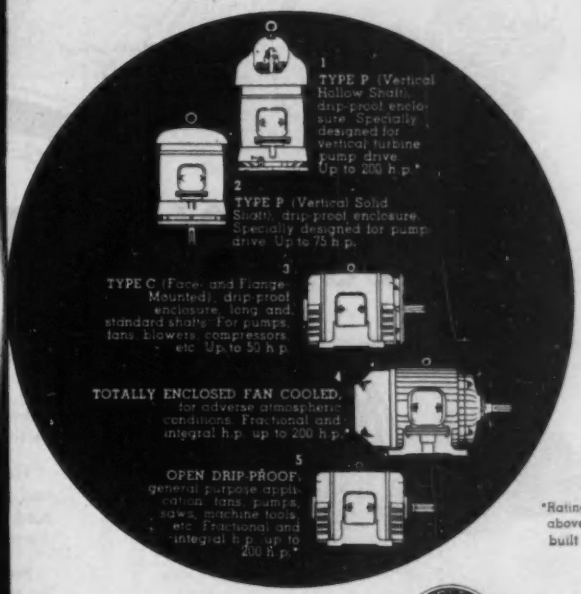
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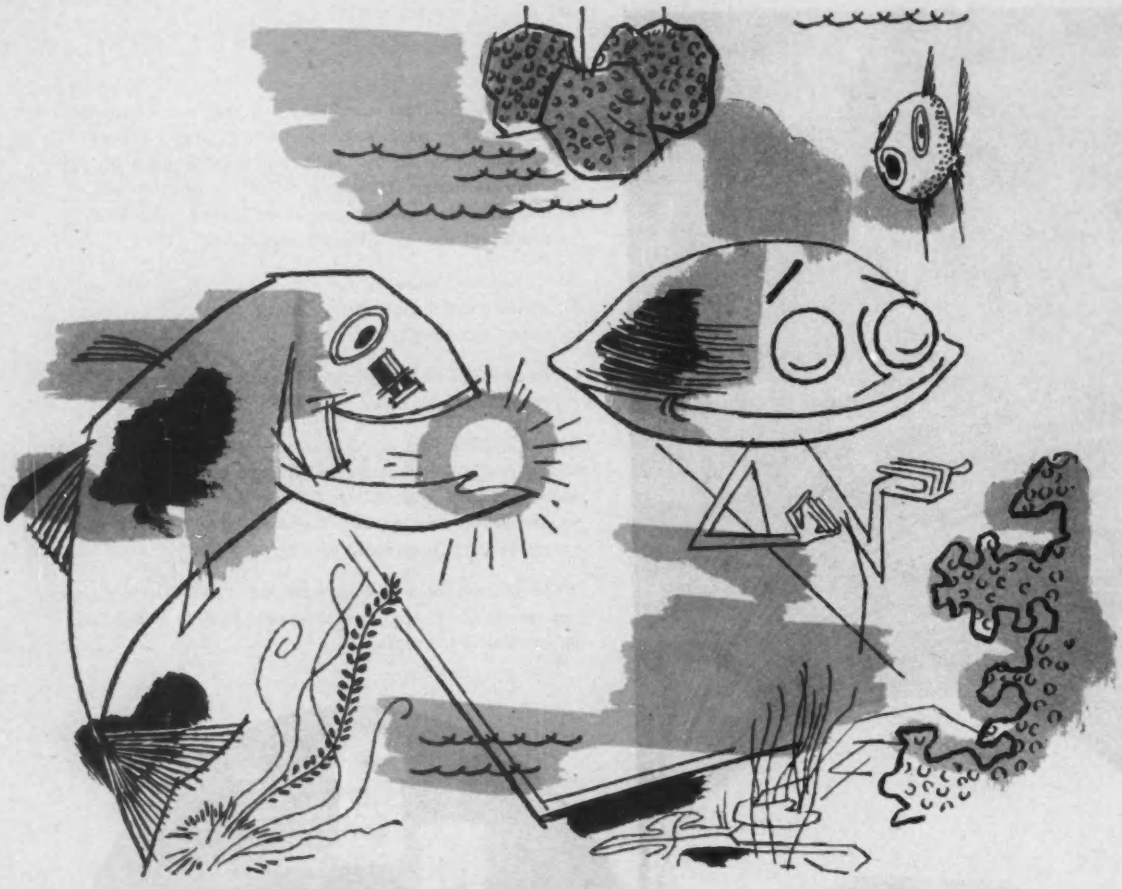

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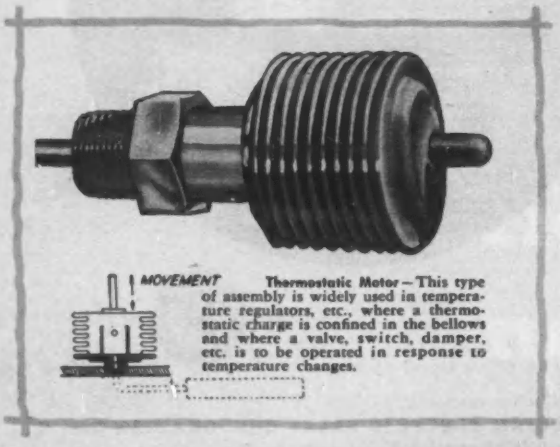

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● Take bellows assemblies, for example. Designing and producing them is a specialty at Fulton Sylphon and Bridgeport Thermostat. Has been for over a half-a-century. So it's only natural that so many users of bellows assemblies come to us.

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Bethlehem Bolts and Nuts are turned out in huge quantities at our fastener plant at Lebanon, Pa. We make just about every type of fastener imaginable, and furnish them either plain or galvanized.

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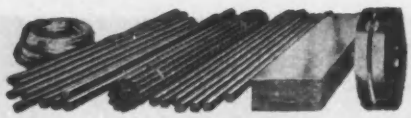

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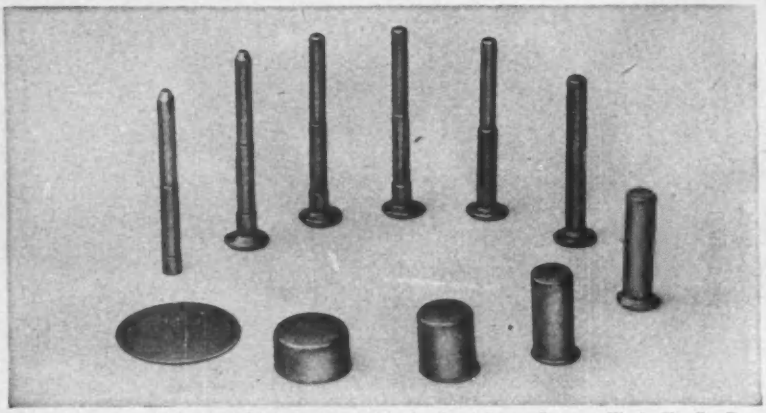


Progressive stages in drawing of brass sac protectors for Snorkel pen. Courtesy W. A. Sheaffer Pen Co., Fort Madison, Iowa

Progressive Drawing on Eyelet Machines Makes Sac Protector for Snorkel Pens

A small tube makes it possible for Sheaffer's new Snorkel fountain pen to breathe in ink without immersing the pen point into the ink bottle. This device eliminates the messy chore of wiping the point after filling.

Heart of the new pen is the brass sac protector which is drawn by Advance Stamping Company, Detroit, Michigan, from brass strip supplied by Bridgeport Brass. The protector, about two inches long and open at one end, fits over the rubber sac which holds the ink supply. The sac and the tube of the Snorkel pen fit into the open end and are retained by a rubber bushing.

The Snorkel Principle

In addition to serving as a protective cover for the sac, the brass sac protector performs a vital role in the operation of the pen. The sac protector is delivered to the manufacturer completely drawn except for the threads which are rolled on at the pen plant. These threads work within another covering brass tube connected to a small knob at the end of the pen barrel. When the knob is turned, the brass sac protector moves downward in the barrel pushing the snorkel tube out beneath the pen point. The tube is inserted in the ink and a downward stroke of the plunger fills the pen. The knob on the top of the barrel is turned in the opposite direction and the tube of the Snorkel pen retracts, leaving the pen ready for writing.

Correct Alloy Vital

The brass sac protector for the Snorkel pen is drawn from Bridgeport rich low brass (85% copper, 15% zinc). This material is .0071 ± .0005 and is supplied in 1¾" strip form. This alloy was chosen because it meets the requirements for eyelet machine operations and also simplifies finishing. It has a fine grain structure which assures a smooth surface. Finishing costs are therefore held to a minimum. This fine grain also imparts strength to the material so that it can withstand stretching during the forming and drawing.

Metal for eyelet machine operations must be high in ductility. Not only must it have the correct temper and grain size, but the metal must have uniformity of anneal and be free from imperfections. Eyelet operations are so severe that poor quality metal results in interrupted production and excessive spoilage.

Economy of Eyelet Machine Operations

Since eyelet machine operations include such stages as blanking, cupping, drawing, piercing and trimming, tool costs are higher than for single press methods. But with long runs, the higher tool and setup costs are absorbed by the constant stream of finished pieces that leave the eyelet machine at low unit cost. With properly designed tools and good lubricants to reduce friction between the metal and the dies, progressive operations can be performed without the danger of too much hardening of the metal during the early stages.

Other important advantages of eyelet machine operations, when the correct copper-base alloy is used, are the elimination of intermediate anneals and of handling separate batches of work for each stage of drawing and forming. Parts are not subject to injury or accumulation of dirt while waiting for available presses.

The sac protector of the pen is an excellent example of eyelet machine production — combining good design, careful processing methods and selection of the correct alloy. The progressive stages of the sac protector drawing are illustrated. After threading, the finished protectors are chrome plated to complement the high finish of the pen and to produce a wear-resistant surface.

Fast production of metal products on automatic machines calls for copper-base alloys of the composition, temper, and grain size which will give the best results with a minimum of finishing cost and wastage. Bridgeport Laboratory will be glad to help our customers in specifying metals that are designed for their particular equipment and their manufacturing methods. Please get in touch with our nearest Bridgeport Office for your metal requirements and for assistance in metal problems. (133)

Wobble means wear

Formula for Failure

$$\frac{w + e + s + \alpha}{x \; v} =$$

a loose connnection

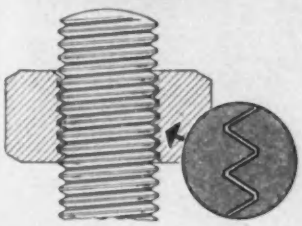
Elastic Stop nuts can't wobble

Formula for Failure—[(w) Initial thread wear + (e) bolt stretch + (s) thermal expansion or contraction + (α) wobble] × (v) vibration = a loose connection.

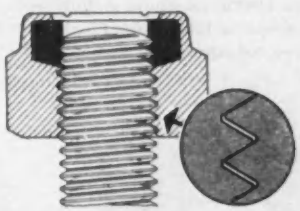
WOBBLE, permitted by normal axial thread play, and vibration are two of the major elements contributing to thread wear, loose connections and ultimate failure of a threaded fastener.

One device — the elastic locking insert — eliminates axial play and dampens destructive, wear-producing vibration. Because of the locking action of ESNA's famous red elastic collar, ELASTIC STOP nuts *do not loosen under vibration.*

Other important ESNA advantages include quick application and precise adjustment, reuseability, protection against liquid seepage, and uniform bolt loading. Mail our coupon for design information.



YOU CAN WOBBLE AN ORDINARY NUT AND BOLT with your fingers. This is the result of the tolerance spread permitted by the several classes of thread fit.



GRIPPING THE BOLT WITH A PERFECT FIT, ESNA's red elastic collar enforces a constant downward pressure that eliminates axial play, enforcing a positive contact between load-carrying sides of bolt and nut threads.

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☐ Here is a drawing of our product. What self-locking fastener would you suggest?

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Only ESNA manufactures a complete line of all types and sizes of self-locking nuts

Farval lubrication holds transfer machine to continuous production

THIS Ex-Cell-O transfer machine is in a famous automobile engine plant. Its job is precision boring of the main bearing line (held to 0.0005 inch tolerance), the cam line (held to plus or minus 0.001 inch) and the distributor bore. It is built to operate at top speed, with uniform precision and efficiency.

To avoid shutdowns for oiling and for bearing repairs that accompany haphazard methods of hand lubrication, a Farval automatic lubricating system was installed. Farval lubricates while the machine is in full operation, entirely eliminating downtime for oiling, increasing bearing life, and allowing higher machine speeds by keeping bearings cooler.

Farval is the original Dualine system of centralized lubrication that delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, as often as desired. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. The easy-to-see indicators at every bearing show that each valve has functioned.

Today Farval protects millions of bearings in the automobile and allied industries, wherever equipment must be lubricated regularly and adequately to keep bearings on the job no matter how hard to get at.

Find out how Farval can help keep your equipment running continuously for maximum production. Write today for free Bulletin 26. The Farval Corporation, 3279 E. 80th St., Cleveland 4, Ohio.

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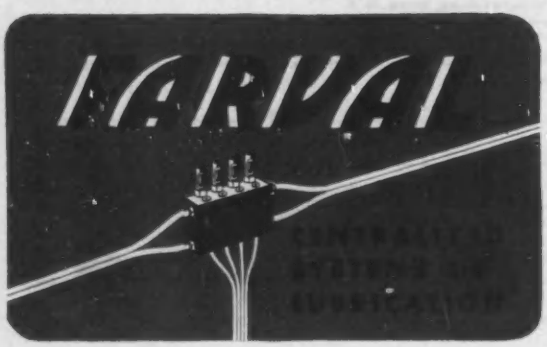
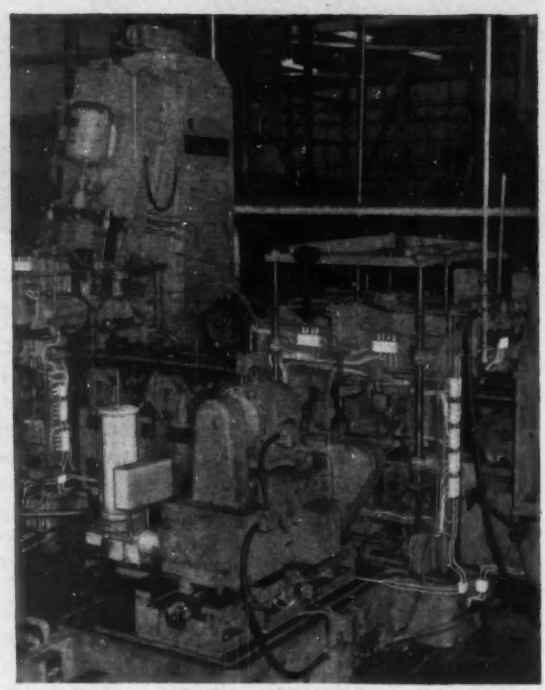


FARVAL—*Studies in Centralized Lubrication* No. 146



KEYS TO ADEQUATE LUBRICATION—Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine will be properly lubricated. Illustration by courtesy of Automotive Industries.

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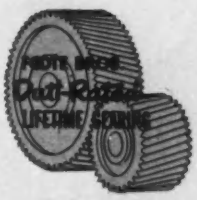
For better drives for every job, see your Foote Bros. representative, or write for helpful information.



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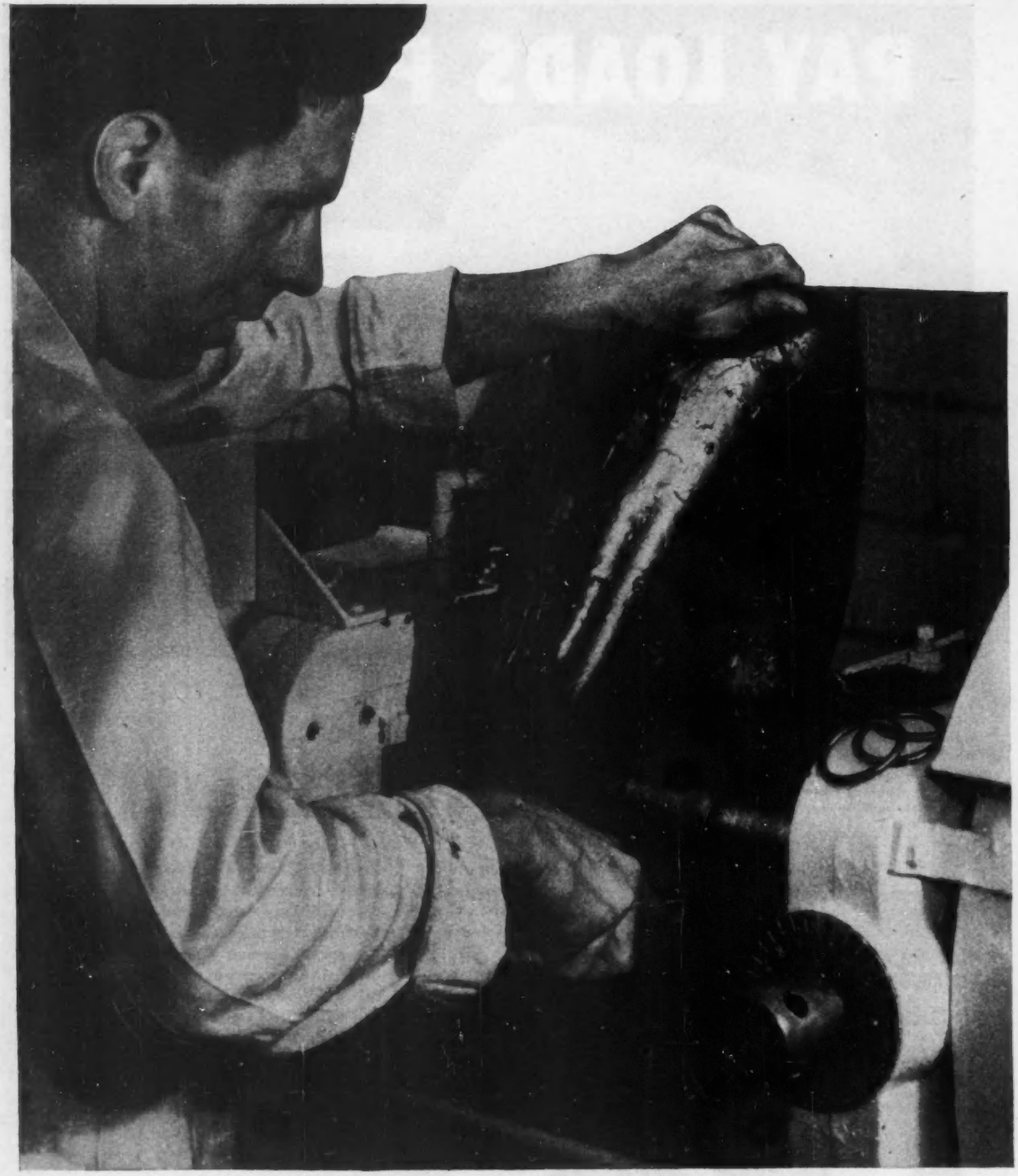

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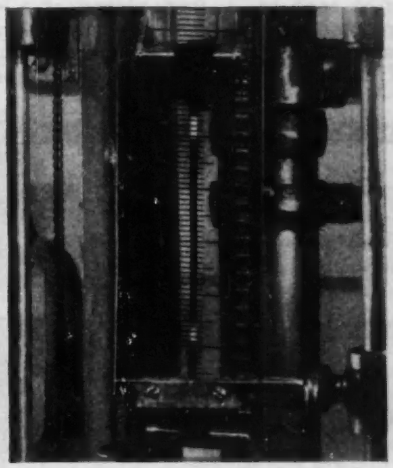
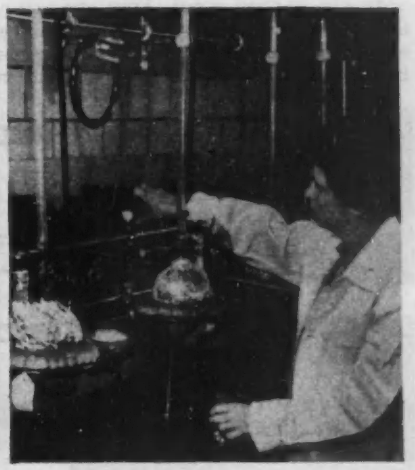
Look how Parker makes sure you get the right O-ring for each specific application

2. Tensile strength is one of the many specifications that each Parker O-ring compound must pass. Other tests prove resistance to both tear and abrasion.



3. Elongation, being tested here, and maximum compression set are other vital factors that determine which compound will assure leakproof O-rings for your application.



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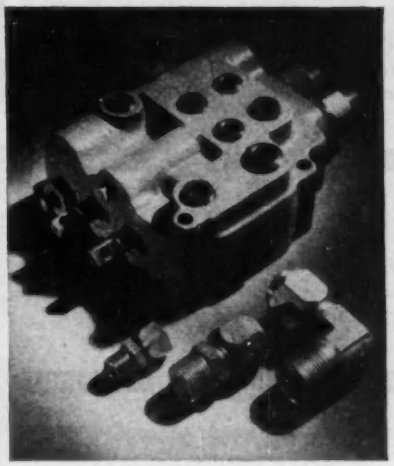

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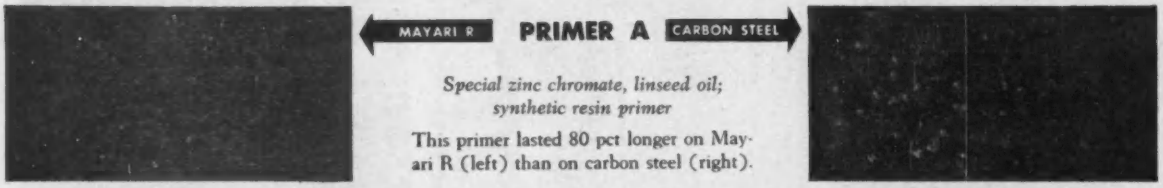
Parker
Hydraulic and fluid system components

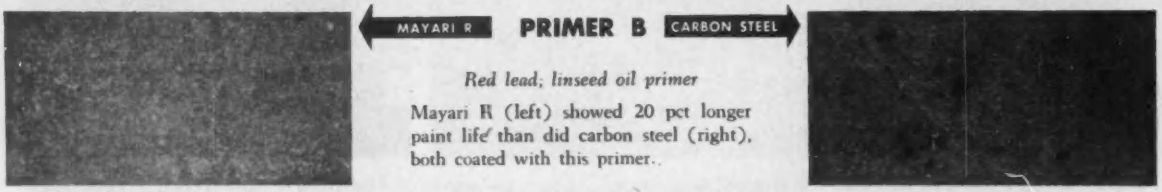
Tests show MAYARI R holds paint 20% to 80% longer

A comprehensive series of tests was run to determine the relative paint-adherence of Mayari R steel and ordinary carbon steel. Five specimens of each of these steels in 4-in. by 4-in. by ¼-in. angle sections with typical partly rusted scale surfaces were wire-brushed, and each given a coating of one of five different types of primer paint at a uniform dry film thickness of 2.5 mils. These painted sections were then placed at a 45-degree angle in a corrosive industrial atmosphere. After the specimens had been exposed under identical conditions for the same period of time, adherence results were as shown below.



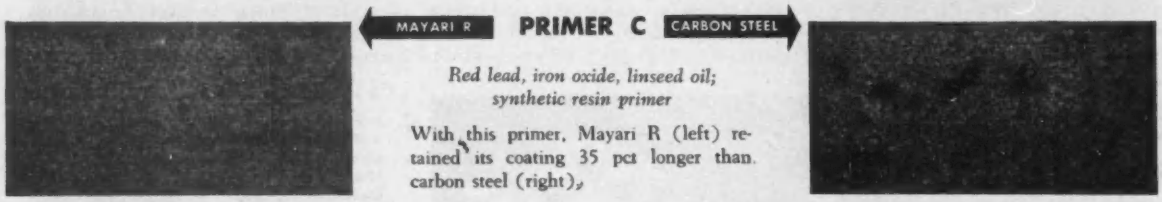
Special zinc chromate, linseed oil; synthetic resin primer

This primer lasted 80 pct longer on Mayari R (left) than on carbon steel (right).



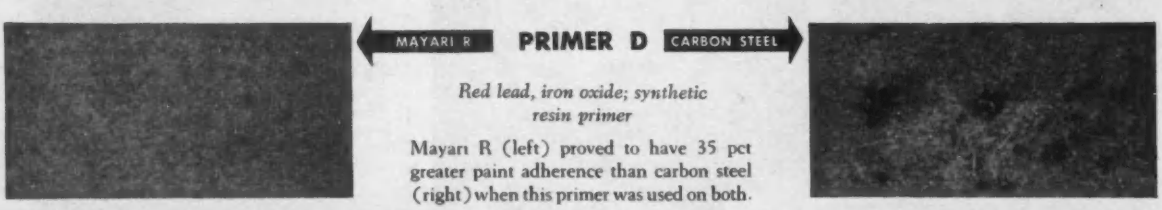
Red lead; linseed oil primer

Mayari R (left) showed 20 pct longer paint life than did carbon steel (right), both coated with this primer.



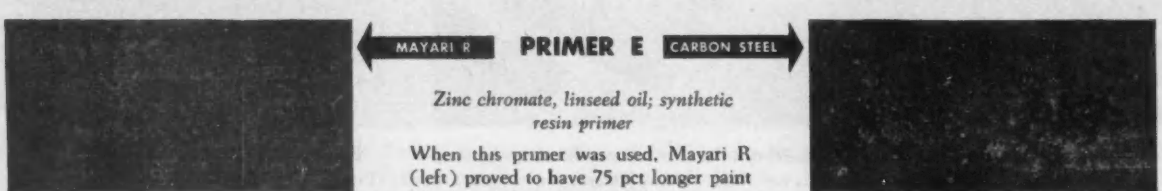
Red lead, iron oxide, linseed oil; synthetic resin primer

With this primer, Mayari R (left) retained its coating 35 pct longer than carbon steel (right).



Red lead, iron oxide; synthetic resin primer

Mayari R (left) proved to have 35 pct greater paint adherence than carbon steel (right) when this primer was used on both.



Zinc chromate, linseed oil; synthetic resin primer

When this primer was used, Mayari R (left) proved to have 75 pct longer paint life than carbon steel (right).

This research investigation, confirmed by the experience of Mayari R users in many industrial applications, shows how important savings in paint and labor are made possible through the use of Mayari R low-alloy, high-tensile, corrosion-resisting steel.

BETHLEHEM STEEL

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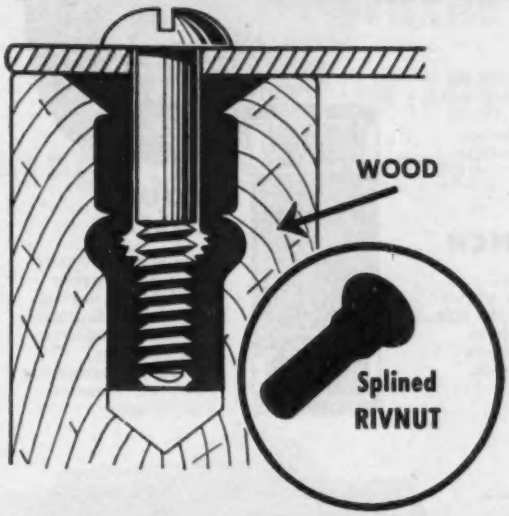
Export Distributor: Bethlehem Steel Export Corporation

B. F. Goodrich RIVNUT set in wood gives 6 clean threads for fastening

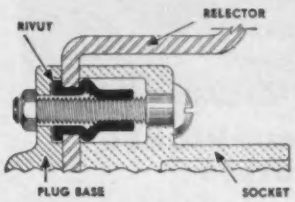


B. F. GOODRICH RIVNUTS eliminate use of wood screws where their frequent removal quickly wears away the wood. Imbedded and upset in wood, a BFG Rivnut provides at least six clean threads for screw attachment. Bulge formed by upsetting with easy-to-use heading tools holds Rivnut fast. Splined shaft or key in Rivnut head provides needed torque resistance.

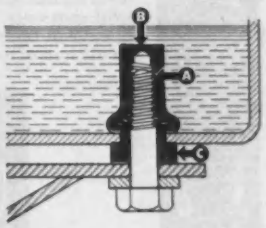
One manufacturer now uses splined Rivnuts to fasten the backs of television sets (see application at left). Screw holes in the cabinet were wearing too big from removal of wood screws.

The splined Rivnut is only one of many types of Rivnuts that solve tough fastening problems in wood, metal, plastic, many other materials. Rivnuts can be installed by *one* man from *one* side of the work in *two* seconds. They can be installed after enameling without marring finish. They save time, cut production costs, make products better. Consult a Rivnut engineer for help with *your* fastening problem. Write **Dpt. PE-123,** for complete information, or send coupon below. The B. F. Goodrich Company, Akron, Ohio.

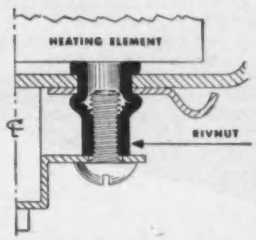
If you have fastening jobs like these, get B. F. Goodrich RIVNUTS



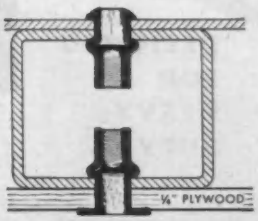
1. DOES 2 FASTENING JOBS! B. F. Goodrich Rivnuts fasten spotlight socket to reflector; same screws hold plug base to reflector. Former method demanded piercing, tapping, welding operations.



3. ELIMINATES BRAZING! Rivnuts with closed end (B) are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated (A). Spacer head (C) positions tank.



2. ELIMINATES REINFORCING PLATE! In assembly of vaporizers, Rivnuts do away with reinforcing plate, don't turn under torque, hold flange securely without bending. Result: less assembly time, fewer parts, better product.



4. FASTENS PLYWOOD TO STEEL! Easier to install than wood or self-tapping screws, Rivnuts fasten plywood walls to tubular steel sections in trailers. No wood filler needed.

B.F.Goodrich
RIVNUT

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how Rivnuts work. Explains construction, gives proved applications.

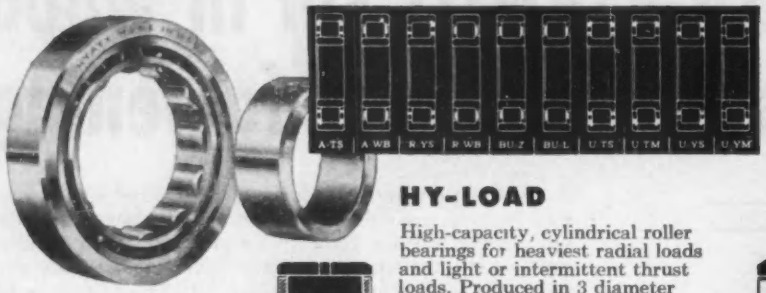
THE B. F. GOODRICH COMPANY
Dpt. PE-123, Akron 18, Ohio

Name .....

Company ..... *Title* .....

Address .....

City ..... *Zone* ..... *State* .....

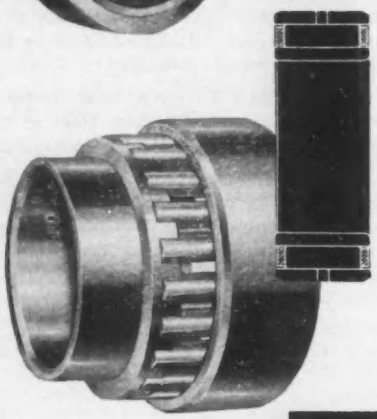


HY-LOAD

High-capacity, cylindrical roller bearings for heaviest radial loads and light or intermittent thrust loads. Produced in 3 diameter series, 2 widths and more than 800 sizes.

WOUND ROLLER

This is a three-part separable bearing available in various width classifications. The roller construction provides maximum resistance to shock, abrasion and fatigue.

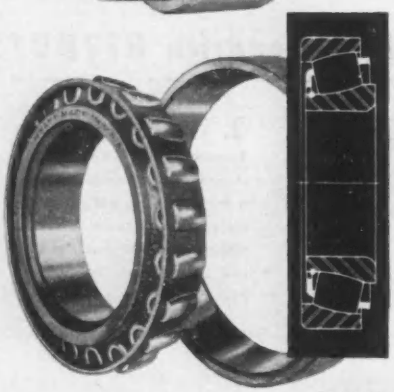


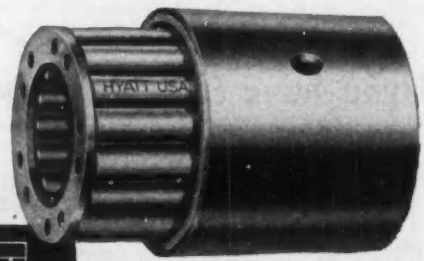
INDUSTRIAL INCH

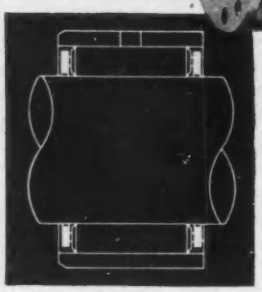
Designed for slow-moving, heavily loaded machinery where large-diameter shafts are the rule. Accordingly, it is available in fractional-size bores for shafts from 4" in diameter upwards.

BARREL

A series of angular-contact, self-aligning bearings capable of sustaining both radial and thrust loads. Race and roller curvatures insure ideal distribution of load, not only for normal operation but also for conditions of misalignment.







TRUNNIONED ROLLER

Ideal for industrial trucks, textile machinery, gear pumps, conveyors, hoists and agricultural equipment. Rollers have trunnioned ends which fit into holes in the end rings. End rings are located and held parallel by spacing bars which also guide and retain rollers.

DESIGNED FOR HEAVY DUTY...

HYATT ROLLER BEARINGS

...and there's a type and size for every need

Hyatt's complete line of radial and angular-contact bearings—*more than 800 sizes in the Hy-Load series alone*—makes the engineers' job easier, because it makes possible greater design flexibility. For the equipment *buyer*, this means longer bearing life and lower maintenance costs—with just the right bearings designed into every vital load-carrying position.

The next time you buy new equipment, or make a changeover, *specify lower maintenance costs by specifying Hyatt Bearings!* And if you need technical help in your selection of bearings, or desire information about particular bearings or their applications, ask for the services of a Hyatt sales-engineer. Call or write Hyatt Bearings Division, General Motors Corp., Harrison, N. J.

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION

WATER

WHEN AND WHERE REQUIRED FOR THE SUPER CONSTELLATION

PASSENGERS aboard Lockheed's luxurious Super Constellation naturally *expect* a dependable and ample supply of clean water. Thanks to Lear-Romec's efficient turbine water pumps, they get it. And along with these niceties for passengers, comes a break for maintenance personnel. Utilizing pressure feed instead of gravity, tanks are installed below the floorboard, making for simple servicing. The compact pump mounts vertically on the under side of the water tank, with all plumbing and electrical connections exposed for easy access.

The Lear-Romec pump illustrated is a submerged turbine-type water utility pump. It is one of a series available in AC and DC motor drive, originally developed for military aircraft, and produced by Lear-Romec for the past ten years. Weighs 2.8 pounds less than equivalent model vane-type pumps. Similar turbine type pumps are also furnished by Lear-Romec for aircraft engine water injection systems.

Bring your pump problems to Lear-Romec—*specialists* in aircraft fluid system components.

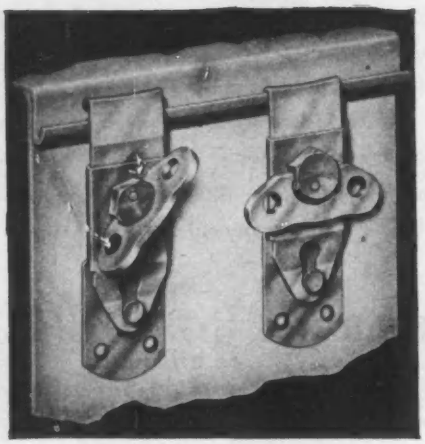
LEAR INC. LEAR-ROMEC DIVISION
ABBE ROAD, ELYRIA, OHIO
Executive Offices: 3171 S. Bundy Drive, Los Angeles 34, Calif.

LEAR-ROMEC MODEL RR-9700-A A fully submerged type turbine aircraft pump. Supplies wash water or anti-detonant solution. Nominal rating 110 gph at 35 psi discharge. Adjustable in range to 25 psi at 150 gph. This unit is 27 volt DC, 11 amps. continuous duty, and has integral radio noise filter on the motor. Weight 5.68 lbs.

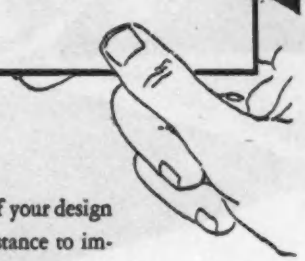
RO-4

Have you a similar fastening problem?

File: Simmons LINK-LOCK



When the armed forces needed a positive, high-strength fastening device for instrument housings, transit cases, and storage boxes, Simmons developed LINK-LOCK. This *brand-new* device doesn't use springs, yet works with fingertip pressure through a unique mechanical arrangement: the vertical sliding latch is moved in and out of locking position by a disc rotated with a wing nut. The fastener is immune to low temperatures, is easy to operate even with arctic mittens, furnishes up to 450-lb. pull-down pressure. Open or closed, it lies flat against the side of the case it fastens.

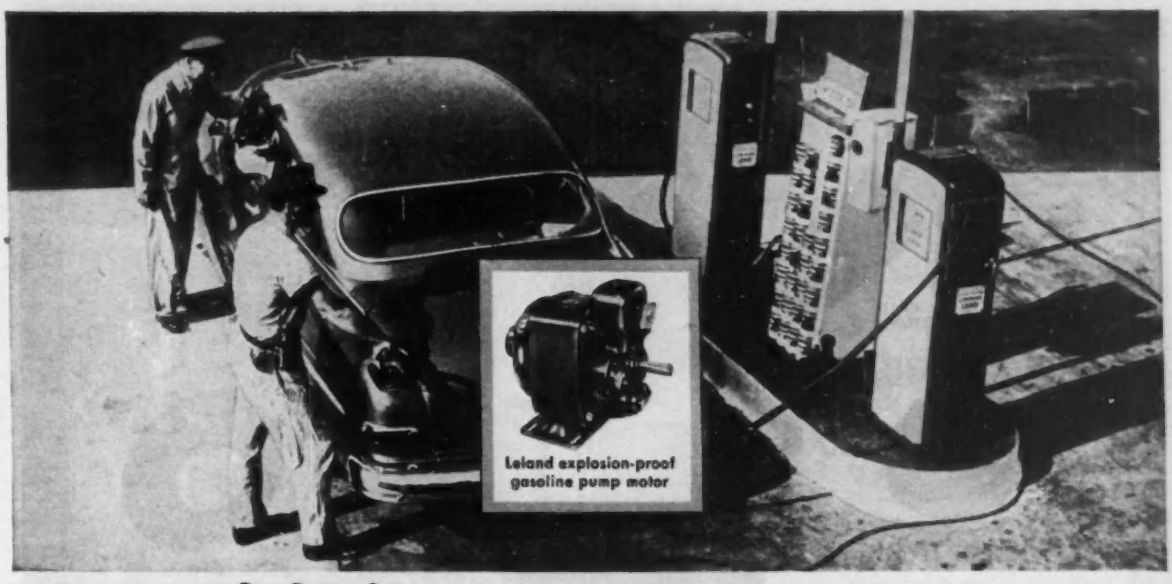


LINK-LOCK may be the answer to your fastening problem. If your design involves heavy fastening pressures, watertight sealing, high strength, resistance to impact, ask about LINK-LOCK. Simmons can furnish it with special engagement-latch details, or for operation by bolt or screwhead instead of wing nut. Write for LINK-LOCK DATA SHEET today. It gives complete details and dimensions. A Simmons engineer will be glad to work with you on your fastening problems.

SIMMONS FASTENER CORPORATION, 1751 No. Broadway, Albany 1, New York

Simmons QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

JUST OUT! NEW 36-PAGE CATALOG WITH APPLICATIONS. SEND FOR IT!



Look to LELAND— when hazardous atmospheres call for Explosion-Proof Motors!

The name LELAND is synonomous with dependable, safe electric motor performance—particularly in the distribution and sale of volatile petroleum products.

It is no accident that Leland, during the past 30 years, has supplied more motors for the powering of gasoline dispensing pumps than *all other manufacturers combined.*

Building motors of superior quality and performance, and providing close engineering liaison with its customers are policies that have been consistently maintained by Leland. As in pioneering the curb gas pump motor design with the Underwriters' Laboratories and leading pump manufacturers, Leland has worked with many other manufacturers. The emphasis is still on quality design and superior fabrication of motors—open, totally enclosed, or explosion-proof—standard or special.

A recent Leland development is a low voltage DC explosion-proof motor for power hose reels on trucks handling inflammables and volatiles. These are now widely used on airport fueling and crash trucks, gasoline and fuel oil delivery trucks, etc. Other examples of Leland's *creative electrical engineering* are contained in Bulletin P102-A. May we send you a copy?

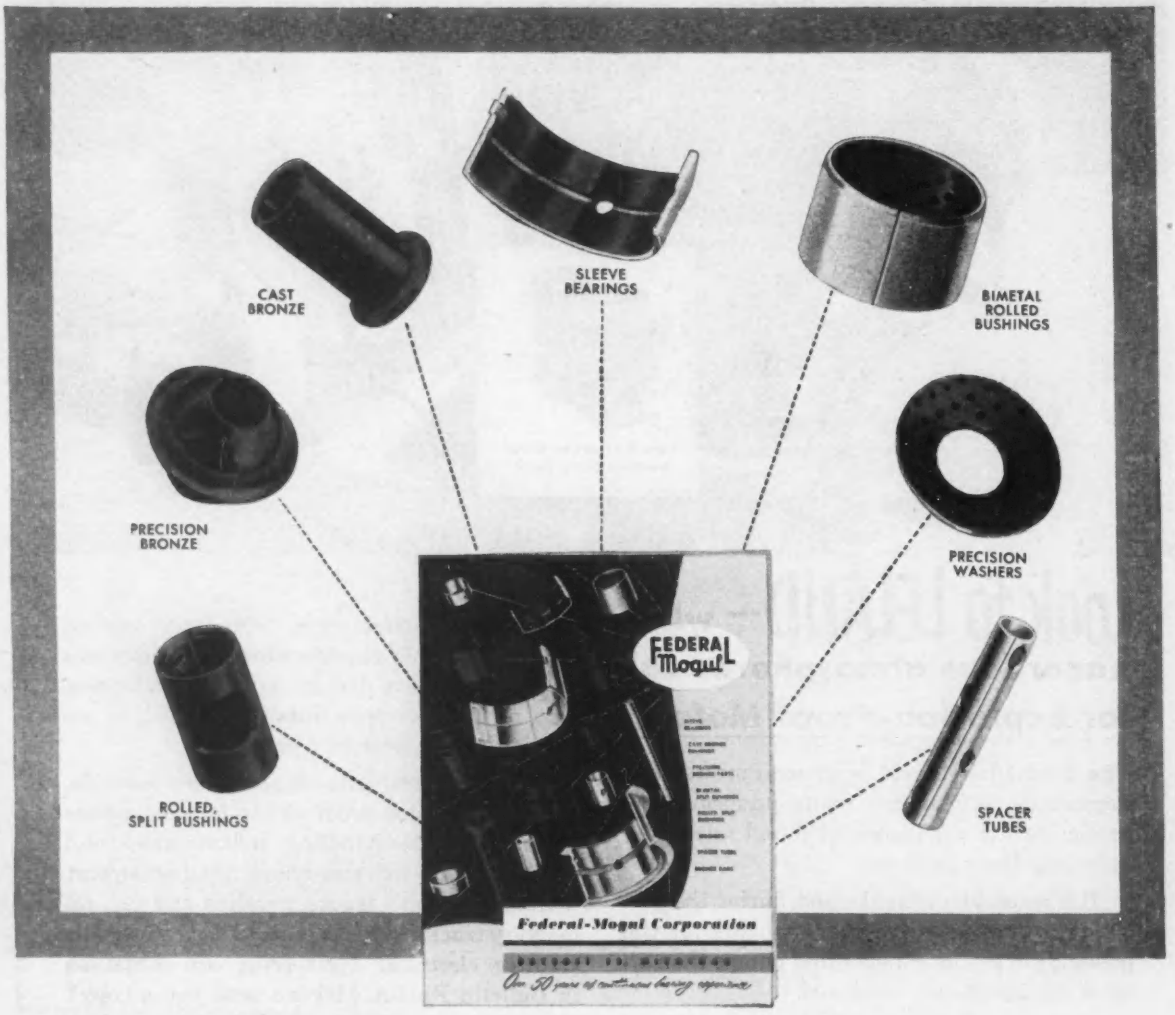
The LELAND ELECTRIC Co.

DAYTON 1, OHIO

Div. AMERICAN MACHINE & FOUNDRY COMPANY, New York

In CANADA, Leland Electric Canada, Ltd., Guelph, Ontario

amf products



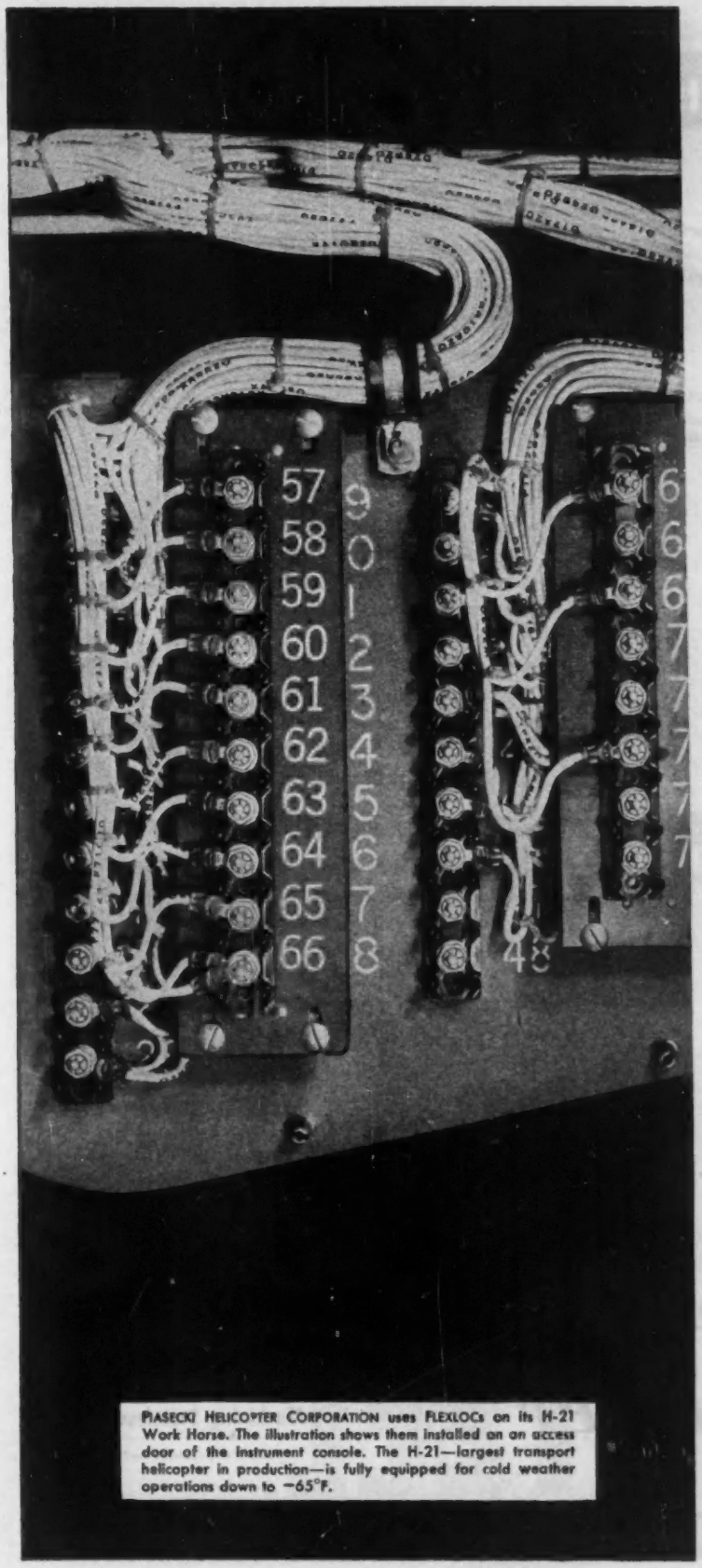
This handy reference catalog on Sleeve Bearings and related products is yours

Free Here is a wealth of helpful, descriptive information on all types of sleeve bearings . . . on bearing metals, precision bronze parts and washers and similar products. Complete information on sintered and special-process copper-lead bearings . . . on how bearing performance is obtained at bushing costs with bimetal bushings . . . how costly seamless tubing or pipe can be replaced in many applications with low-cost spacer tubes. Condenses over 50 years' experience as specialists in sleeve bearings and related products. Your business letterhead request brings your *free* copy promptly. No obligation—write today!

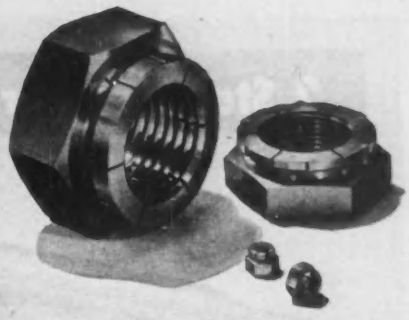
FEDERAL Mogul

FEDERAL-MOGUL CORPORATION • 11043 SHOEMAKER • DETROIT 13, MICH.

since **FEDERAL-MOGUL** 1899



PIASECKI HELICOPTER CORPORATION uses FLEXLOCs on its H-21 Work Horse. The illustration shows them installed on an access door of the instrument console. The H-21—largest transport helicopter in production—is fully equipped for cold weather operations down to −65°F.



Why use FLEXLOC locknuts?

The answer is simple. They hold assemblies together, and won't work loose like ordinary nuts. Once you install these one piece, all metal nuts, you can forget them. Yet they can be easily removed and can be reused again and again.

No fastening job is too tough for a FLEXLOC. Whether it's on an access door of a Piasecki Helicopter or the picker stick of a high speed loom, a FLEXLOC stays put.

FLEXLOCs save production and maintenance time. They are one piece, all metal—nothing to assemble, come apart, lose or forget. Standard FLEXLOCs have higher tensile than most other nuts—and because they are all metal, are not affected by temperatures to 550°F.

SPS can deliver any quantity of FLEXLOCs in a wide range of sizes. Stocks are carried by industrial distributors. Write for literature and samples. SPS, Jenkintown 28, Pa.

FLEXLOC®

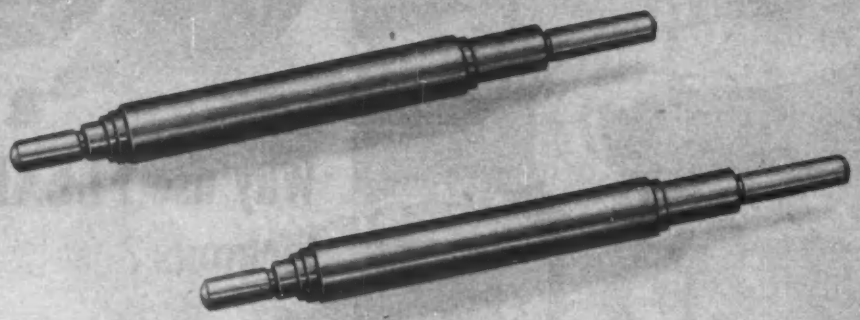
LOCKNUT DIVISION

SPS

JENKINTOWN PENNSYLVANIA

Our Fiftieth Year : A START FOR THE FUTURE

2 Stainless Parts... *look alike*



but with 1 of them

The job becomes profitable

This main shaft for a fishing reel was anything but sport for the manufacturer. The steel used had to have excellent corrosion resistance, concentricity, close and uniform tolerances as supplied, and good machinability. With ordinary Type 416 Stainless, the Company just couldn't produce the shafts at a profit. But when the manufacturer made just *one* change ... to Carpenter Stainless No. 5 (Type 416)... the profit picture changed completely.

Tool breakage is eliminated

Another problem when the ordinary Type 416 Stainless was used, was a serious rate of tool breakage. And here again, just one change... to Carpenter No. 5... eliminated this headache.

All requirements are met

With Carpenter No. 5, the manufacturer now reports that *all* requirements are met and the shafts are coming off the line at a good rate. Here's just one more example of the difference Carpenter builds into stainless steels. Specify *Carpenter* on your next stainless order and see the profitable difference all along the line from initial operation to finished part.

Make the one change that counts...

change to *Carpenter* STEEL

Free-Machining Stainless

take the problems out of production

THE CARPENTER STEEL COMPANY, 117 W. Bern St., Reading, Pa.
Export Department: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

For fast delivery, call your nearest Carpenter Mill-Branch Warehouse, Office or Distributor

extra value for your products...

PACKARD ELECTRIC MOTORS

for:

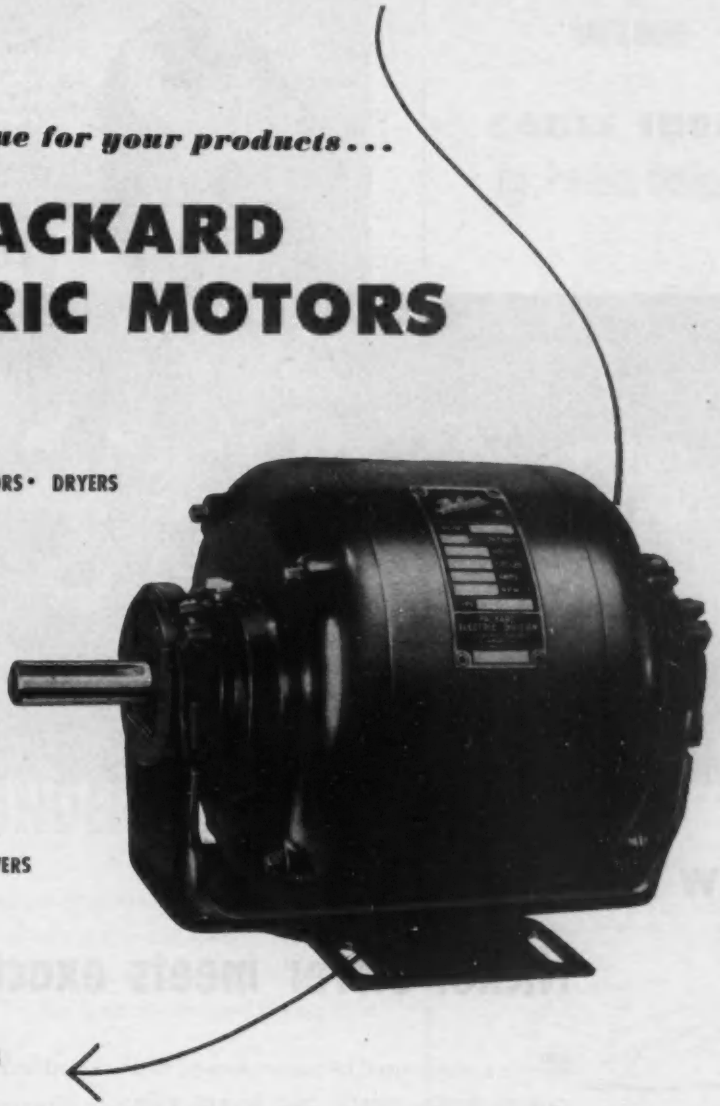
BENCH TOOLS • BLOWERS • COMPRESSORS • DRYERS

DISPOSAL UNITS • WASHERS • IRONERS

OIL BURNERS • STOKERS • LAWN MOWERS

WATER PUMPS • MILKING MACHINES

CREAM SEPARATORS • VENTILATING UNITS



When your product is powered with a Packard Electric motor, its performance and reliability make it a salesman that never stops selling for you.

Packard Electric's tremendous facilities for volume production make it possible for you to put these "silent salesmen" to work for your motor-powered products at a surprisingly low cost. Why not get all the facts now, from Packard engineers?

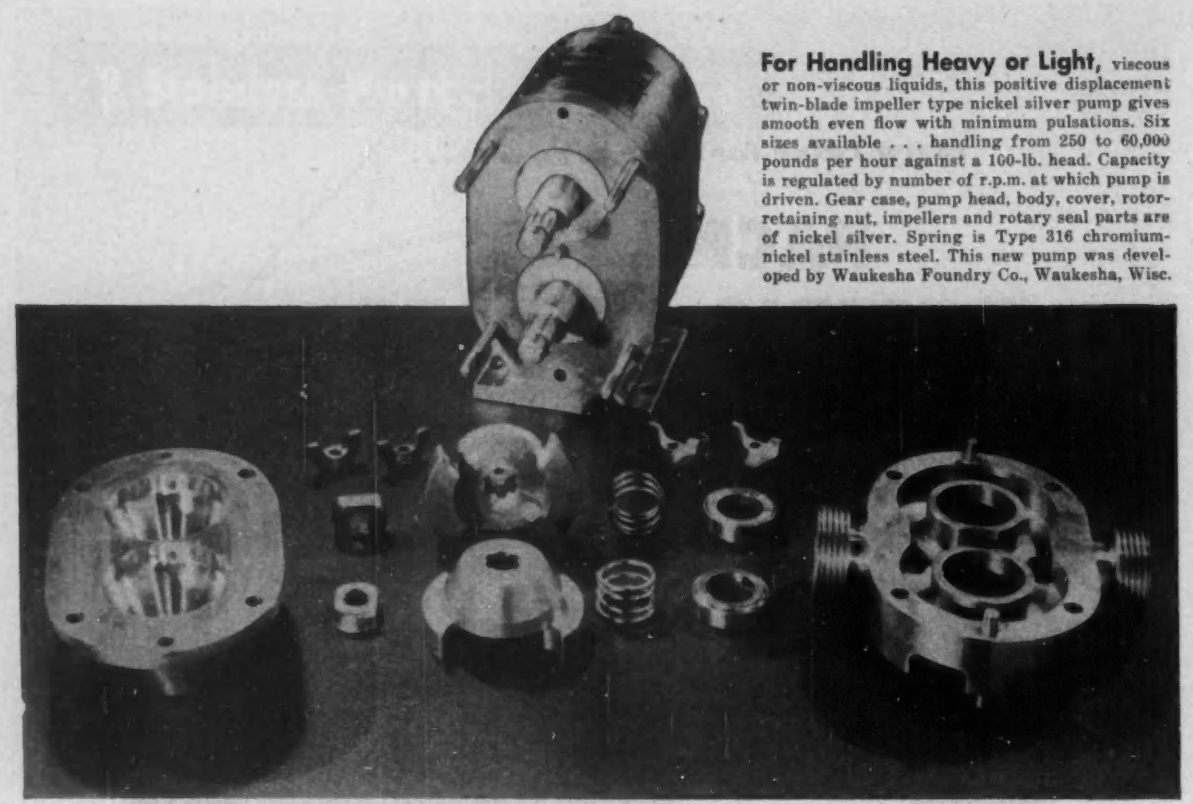
DEPENDABLE APPLIANCE MOTORS FOR THIRTY-SIX YEARS

GM GENERAL MOTORS

Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division
General Motors Corporation
Warren, Ohio



For Handling Heavy or Light, viscous or non-viscous liquids, this positive displacement twin-blade impeller type nickel silver pump gives smooth even flow with minimum pulsations. Six sizes available . . . handling from 250 to 60,000 pounds per hour against a 100-lb. head. Capacity is regulated by number of r.p.m. at which pump is driven. Gear case, pump head, body, cover, rotor-retaining nut, impellers and rotary seal parts are of nickel silver. Spring is Type 316 chromium-nickel stainless steel. This new pump was developed by Waukesha Foundry Co., Waukesha, Wisc.

NEW PUMP SHOWS HOW

Nickel Silver meets exacting demands

Here's a pump used by processors of milk, canned foods, paints, cold cream, adhesives and scores of other products . . .

Its components are made of nickel silver to provide essential strength, and to assure non-pitting silvery white surfaces that resist wear and corrosion. Moreover, parts with bright, lustrous working surfaces permit quick, thorough cleaning as well as easy maintenance.

Solid white metal all the way through, nickel silvers usually provide greater strength and corrosion-resistance than do ordinary brasses and bronzes.

Wrought or cast, the impressive beauty and moderate cost of nickel silvers . . . plus their ready response to fabrication by ordinary methods . . . make these alloys particularly useful for improving both quality and quantity of output.

Gain competitive advantages by using these alloys. The several grades of nickel silvers permit selecting one with the best set of properties for any reasonable fabrication and service demands. We shall be glad to furnish you with counsel and data on these versatile alloys.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

G-E appliance wires STAND UP UNDER HEAT

Whether your appliance wiring problem is extreme heat, moisture, corrosive vapor, or repeated bending, there's a General Electric appliance wire designed for the job. Here a glass-insulated Deltabeston* hinge wire, used on a waffle iron, is unaffected by the heat, steam, and flexing that would cause an ordinary wire to fail.

Choose the best appliance wires for your job from the complete G-E line of lead, stove, range, grounding, hinge and permanent-wave wires. G-E Deltabeston wires and cables are unsurpassed in performance under severe operating conditions. For more information, write Section W81-1267 Construction Materials Division, General Electric Company, Bridgeport 2, Connecticut.

*Registered Trade-mark General Electric Company

You can put your confidence in—

GENERAL ELECTRIC

WIRE AND CABLE IDEAS for Product Designers

Handy Reference Booklet: 24-page booklet for product designers contains charts, specifications, applications for the complete standard line of G-E wires, cables, and cords. Write for your copy.

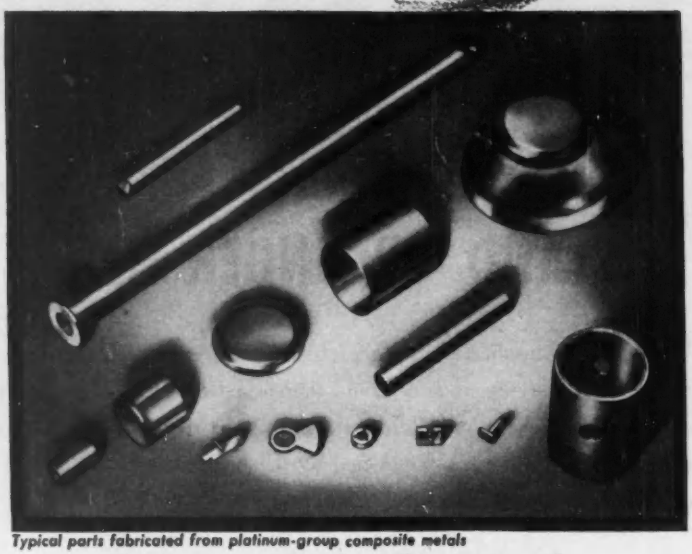
Machine Tool Wire: G-E Flamenol* machine tool wire meets J.I.C. Standards for machine tool control wiring. It is permanently color-coded for easy circuit tracing. Its small over-all diameter is ideal for limited spaces. Flamenol wire is not affected by lubricating or cutting oils, acids or alkalies.

Flexible Cords: Where resistance to heat, moisture, acids, alkalies, water, grease, or oil is important, G-E flexible cords have long been the answer. For light, medium, or heavy-duty electrical appliances or industrial equipment.

Welding Leads: Designed for use either as electrode cables or work cables, G-E leads for arc welders are minutely stranded for maximum flexibility; covered with a smooth rubber jacket for toughness, and abrasion-resistance.

Let us show you how
GENERAL PLATE
Fabricated
PLATINUM-GROUP
Composite Metal Parts and Assemblies...

- ***Increase Strength***
- ***Reduce Weight***
- ***Provide Corrosion Resistance at high temperatures***
- ***Increase Electrical and Thermal Conductivity***



Typical parts fabricated from platinum-group composite metals

...and Reduce Material Costs!

By letting General Plate fabricate your platinum-group metal parts and assemblies, you will save money, time, and trouble... needless dies and other equipment costs and scrap disposal are eliminated... experimental and assembly adjustments are crossed from your books. The finished parts are made to your exact specifications and shipped to you ready for installation.

General Plate's complete fabricating facilities blank, stamp, form, spin, draw, turn, and mill parts; and produce staked, welded, or brazed assemblies.

Typical fabricated products include platinum-tipped contacts and contact assemblies, collector rings, linings for vessels, custom-made crucibles, thermocouple wires, electrodes, etc.

General Plate also produces platinum-group metals in solid and composite form in sheet, wire, tubing, foil, and gauze. In composite form, the noble metal provides the necessary performance characteristics, the base metal greatly reduces costs without sacrificing the desirable characteristics of the pure noble metals.

In addition, General Plate has complete modern assaying and refining facilities which include a complete refinery for the recovery of platinum and platinum-group metals.

Send in your specific problems for discussion and ask for Bulletin PR718.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
112 FOREST STREET, ATTLEBORO, MASSACHUSETTS

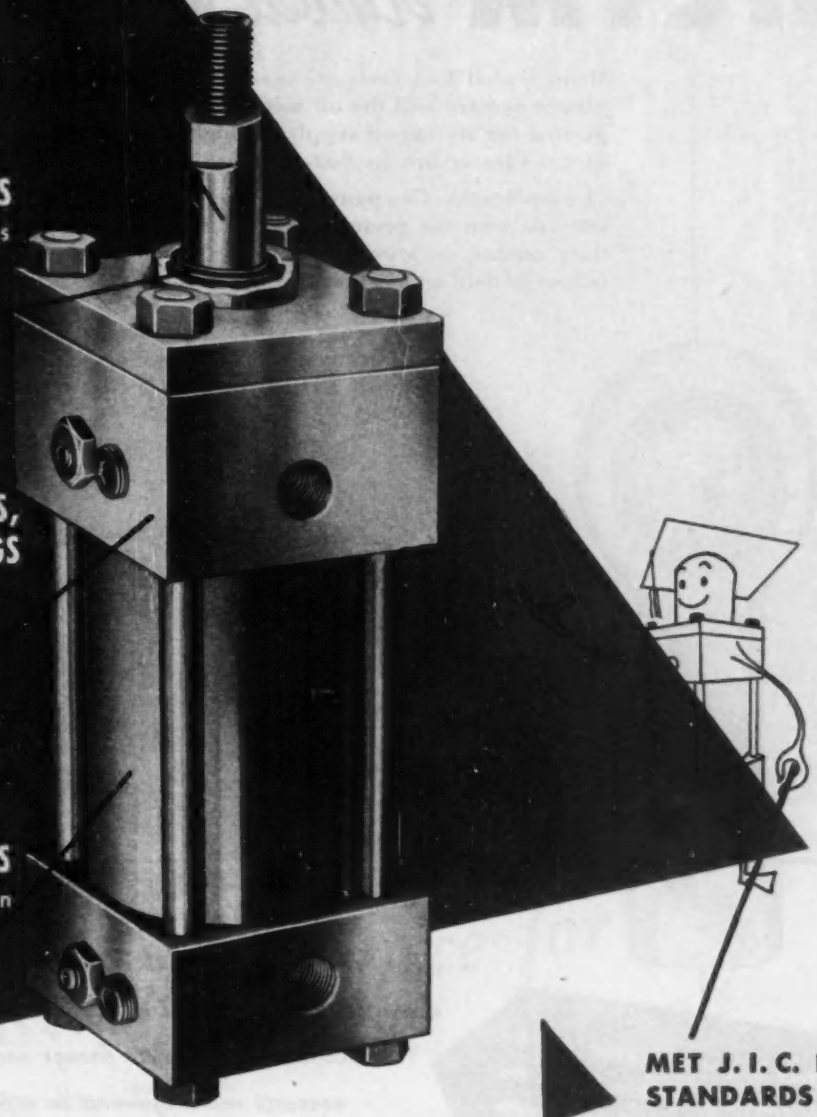
Miller AIR CYLINDERS

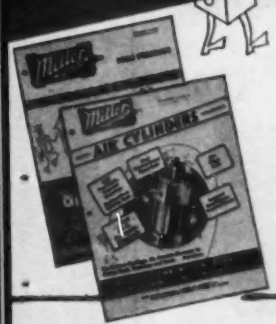
HARD CHROME PLATED PISTON RODS
Prevent Scratch-Damage, Nicks and Rust

DIRT WIPER SEALS
Protect Rods, Seals, Bushings

SOLID STEEL HEADS, CAPS and MOUNTINGS
Eliminate Breakage

BRASS BARRELS
Eliminate Rust and Corrosion





WRITE FOR CYLINDER BULLETINS A-105 and H-104

Complete Miller cylinder line includes: air cylinders, 1½" to 20" bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

MET J. I. C. PNEUMATIC STANDARDS years before their adoption in 1950.

SPACE-SAVING SQUARE DESIGN originated by Miller in 1945.

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CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

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AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
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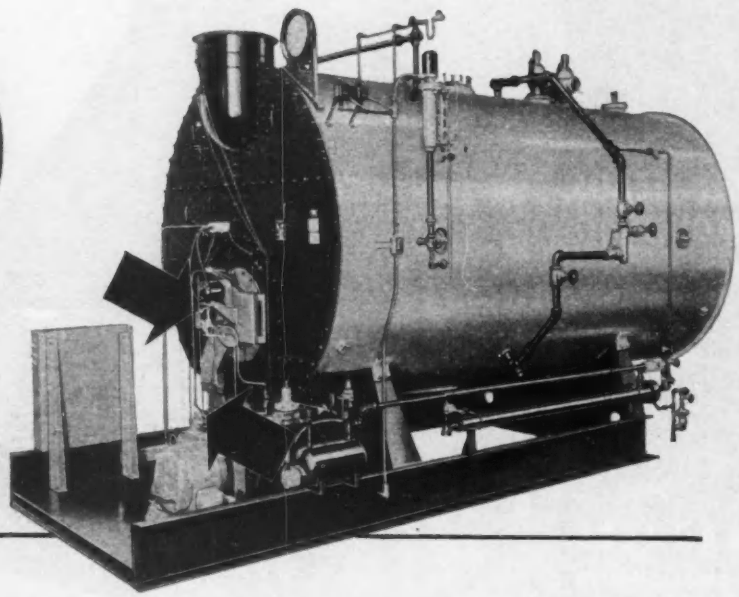
never a failure with . . .

HEIM *Unibal* ROD ENDS

Heim Unibal Rod Ends are used in the linkage between the blower damper and the oil metering valve, and serve to proportion the air and oil supply for high and low fire operation of this Cleaver-Brooks Self-contained Boiler.

Cleaver-Brooks Company's engineering department is well satisfied with the performance of the Heim Rod Ends, and their service department has never encountered a rod end failure in field applications.



Your Engineering Dept. will be interested in the Heim Unibal. We will be happy to send you a sample bearing with our complete catalog.

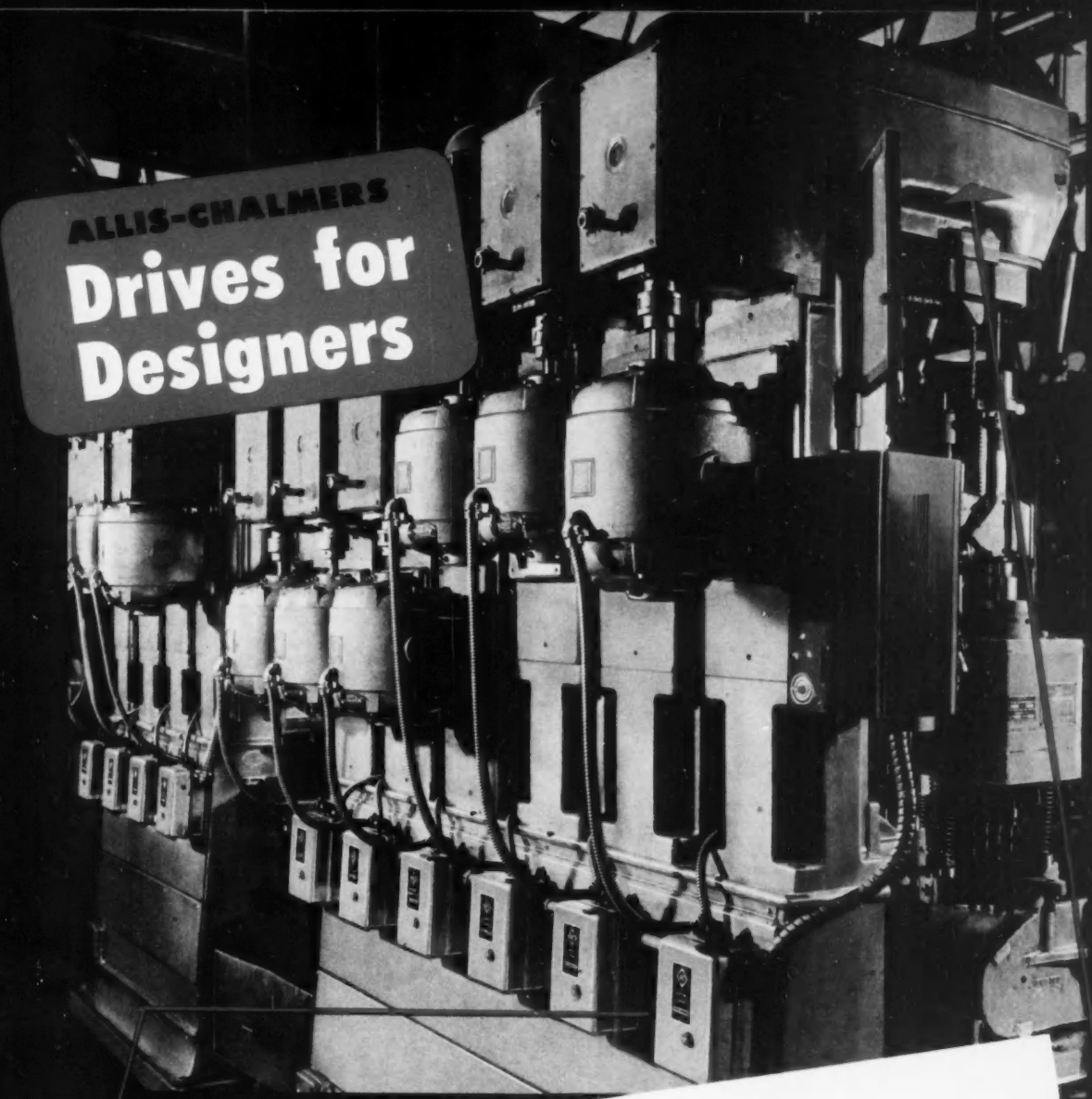
The Heim Unibal Rod End has a single, hardened ball which oscillates freely in all directions in its bronze socket. It corrects misalignment in all directions; it reduces friction and lost motion; and it carries heavier loads.

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT . . . . . .

ALLIS-CHALMERS

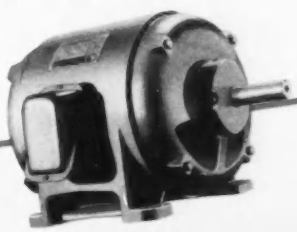
Drives for Designers



One Reliable Source for . . .

Everything from Power Line to Driven Shaft

Control

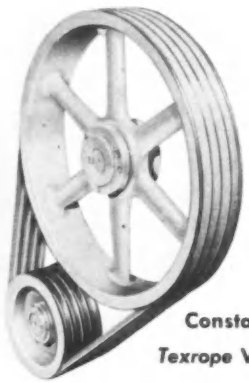


Motor

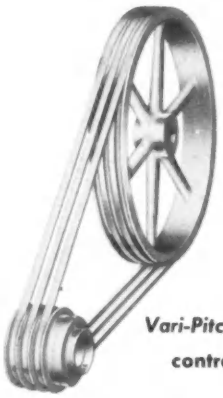
Texrope V-belt Drive

A-4207

Designed to

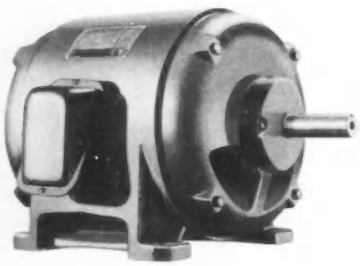


Constant speed
Texrope V-belt drive



Vari-Pitch stationary
control drive

Vari-Pitch motion
control drive



Open, drip-proof
squirrel cage motor

Totally-enclosed, fan-cooled
squirrel cage motor

Open, drip-proof, face-mounted
vertical squirrel cage motor

Across-the-line manual starter

Combination
starter

Reduced voltage starter

ALLIS-CHALMERS

Work Together

Texrope Drives

Texrope V-belt drives, the original multiple V-belt drive, are available in a complete range of sizes and types, both fixed and variable speed. More and more designers are finding that the moderate cost of *Vari-Pitch* sheaves is returned many times in increased machine versatility and more precise quality control. With either Stationary Control or Motion Control *Vari-Pitch* sheaves, speeds can be accurately adjusted quickly and easily over a wide range.

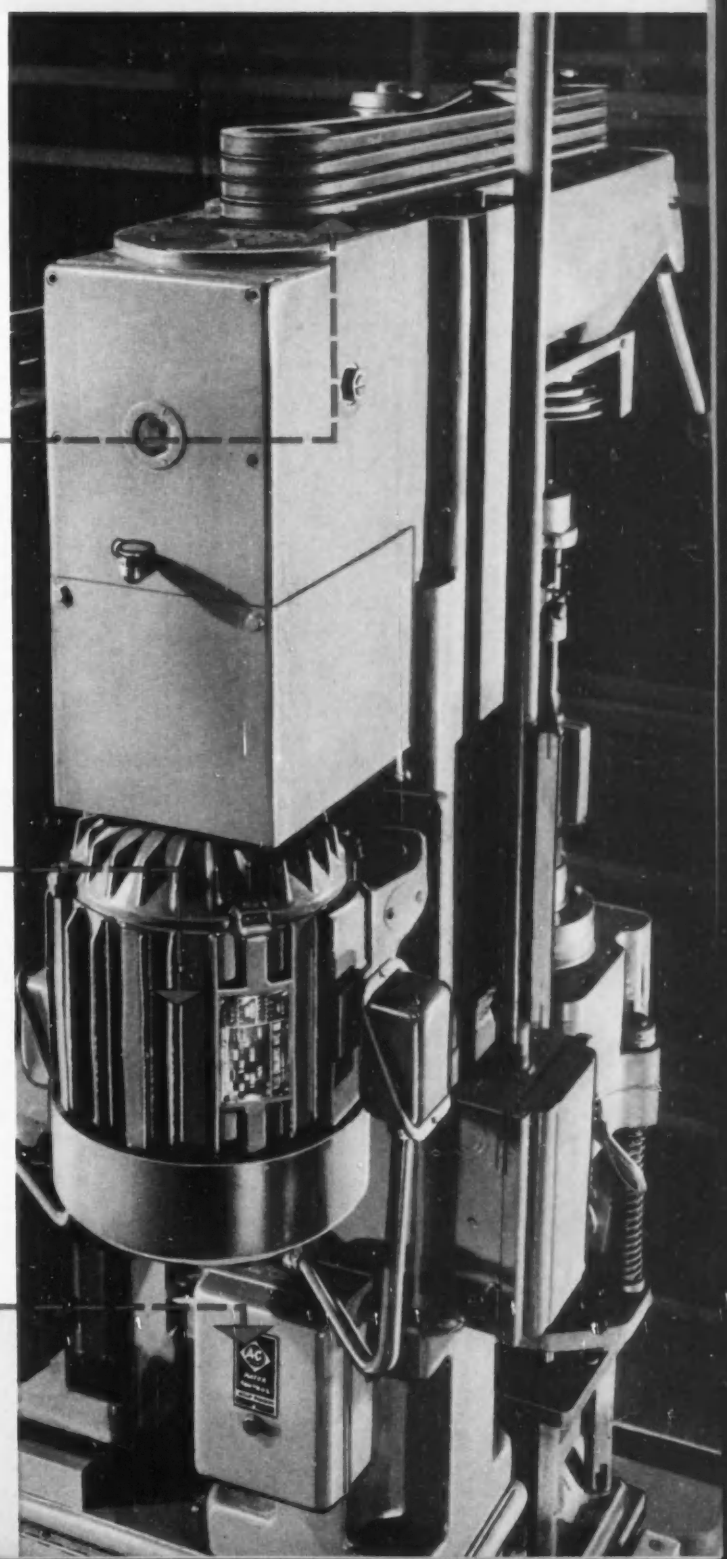
Texrope and Vari-Pitch are Allis-Chalmers trademarks.

Motors

Allis-Chalmers general purpose, special purpose and special design motors meet almost every designer's needs for motors from ½ hp up. Types include squirrel cage, wound rotor and dc for single or multi-speed operation. Available with a full range of torque characteristics and a wide option of enclosures and mounting methods. Special designs to meet any requirement. Shown at the right is a drilling machine equipped with a totally-enclosed, fan-cooled Allis-Chalmers motor. Reduced maintenance of the dirt-excluding fin-type design is making it very popular for machine tool applications.

Motor Control

Allis-Chalmers motor control is available for most designers' applications from size 0 up. Allis-Chalmers builds many types of squirrel cage and wound rotor motor control, dc motor control, and variable speed control for many applications. Shown here is a full voltage across-the-line starter with reset button.



A-C ALLIS-CHALMERS

Everything from Power Line to Driven Shaft

Nation Wide Service

YOUR CUSTOMERS will have no trouble getting competent service on your products when you use Allis-Chalmers motors, control and drives. There are nearly 100 Allis-Chalmers Certified Service Shops located in every industrial area in the country.

Allis-Chalmers Certified Service Shops are hand-picked independent units which have been chosen for their modern equipment, efficient methods, wide experience and business integrity. These Certified Service Shops assure your customers of factory-approved parts and service methods on Allis-Chalmers drive equipment. If you use special motors, the factory makes available to all Certified Service Shops the necessary information to assure a good service job.

ALLIS-CHALMERS

Milwaukee 1, Wisconsin

SEND THIS COUPON TODAY

Allis-Chalmers Manufacturing Company
Box 512
Milwaukee 1, Wisconsin

A-4207

Please send me the literature for designers checked below.

Motors

- ☐ Handy Guide to Motor Selection 51B6052
- ☐ Squirrel Cage Motors 51B6210

Control

- ☐ Handy Guide to Starters 14B7733
- ☐ Reduced-voltage Starters 14B7215

***Texrope* Drives**

- ☐ Handy Guide to *Texrope* Drives 20B6051
- ☐ *Vari-Pitch* Drive Engineering Data 20B7499

Name..... Title..... Company.....

Address..... City and State.....

Facts about *HELI-COIL* inserts you should know

What they are

Heli-Coil* screw thread inserts are precision formed coils of stainless steel or phosphor bronze wire. Wound into tapped holes, they form permanent, non-corrosive, strip-proof threads of astonishing strength. Available for National Coarse, National Fine and Unified threads, pipe threads and spark plug threads. They are made in all standard sizes and lengths for assemblies requiring Class 3, 3B, 2 or 2B fits.

What they are for

AS ORIGINAL COMPONENTS: *Heli-Coil* inserts are used to provide stronger, lighter fastenings, corrosion-proof, wear-proof threads in all assemblies.

FOR PRODUCTION SALVAGE: When conventional tapped holes are damaged in production, restore them on the line with *Heli-Coil* inserts. Get better-than-original strength with no increase in screw size and no tell-tale signs of rework.

FOR SPEEDY REPAIRS: When tapped threads wear, strip or corrode in service, renew them in minutes on location in shop or field with *Heli-Coil* inserts. No welding—no plugging—no secondary machining—no oversize screws.

How they work

Holes are drilled and tapped as you do for ordinary threads—then *Heli-Coil* inserts are wound into tapped holes by hand or power tools. Install in a few seconds, assure thread protection forever. Can be used in any metal wood or plastic.

No other method is so simple, effective and practical.

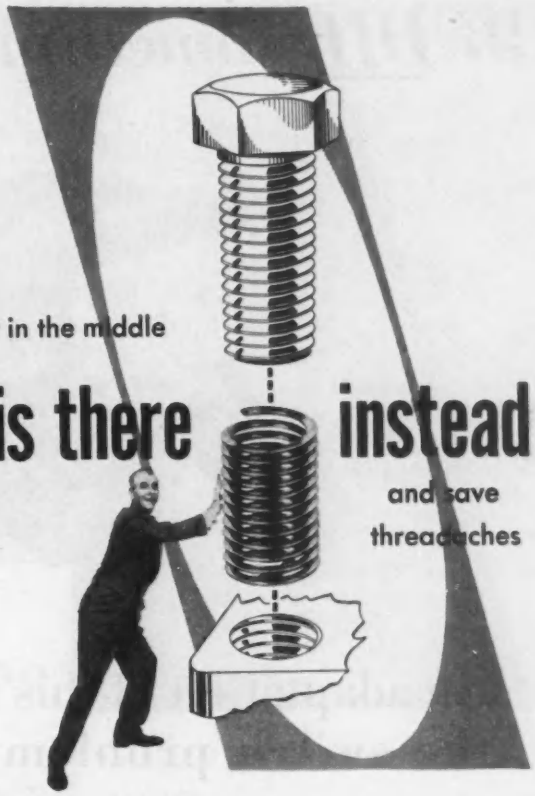
What they do for you

Heli-Coil inserts *save money* because they strengthen threads and make *fewer* smaller fastenings do the same holding job. They make *lighter* bosses and flanges practical and they *save weight* in two ways: (1) by permitting use of cap screws, instead of bolts and nuts; (2) by allowing use of smaller, shorter, fewer cap screws. *Heli-Coil* inserts *protect* your product from thread wear, galling and stripping for life in every kind of metal, in plastics or wood. They preserve customer good-will by preventing product failure, due to thread fault. *Heli-Coil* inserts improve the end product, cut rejects, salvage threading errors.

Best time to put *Heli-Coil* inserts benefits to your use is right at the designing board, as many leading manufacturers are doing. But to convince you of their many advantages ask for a working demonstration right on your production line. Write today! Complete information and engineering data is available in the *Heli-Coil* catalog. Use Coupon!

*Reg. U.S. Pat. Off.

Heli-Coil Inserts conform to official military standards MS-122076 (ASG) through MS-124850 (ASG) and others.



Sales demanding "twice the product at half the price"? Does production want "half the cost and half the time" on the production line? Where are you? Caught in the middle?

You can be a hero to both sales management *and* production management by telling them about *Heli-Coil** Screw Thread Inserts.

These precision formed inserts of stainless steel or phosphor bronze wire make vastly stronger threads in metal, plastics, and other materials. So much stronger that you can safely use smaller and fewer and shorter cap screws—thinner sections, lighter bosses. Thus costs are reduced, production simplified. And threads cannot strip, corrode or gall—they never wear out.

Learn how other designers are using *Heli-Coil* Screw Thread Inserts. Get the technical data you need to apply them to your "threadaches." Use the coupon—now!

*Reg. U.S. Pat. Off.

HELI-COIL CORPORATION
152 SHELTER ROCK LANE, DANBURY, CONN.

☐ Send Free samples and Handbook No. 652, a complete design manual.

☐ Send Free samples and put me on list to receive "Heli-Coil", case history periodical.

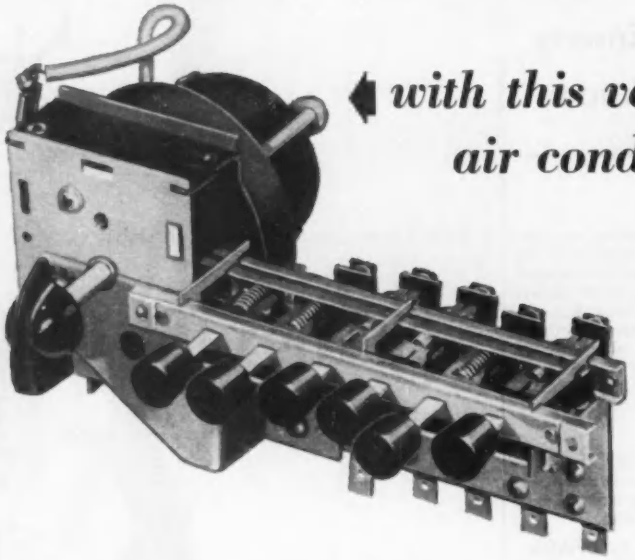
NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

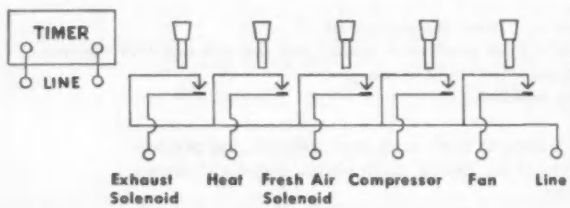
CITY _____ ZONE _____ STATE _____

We DID something about the weather



with this versatile air conditioner switch

An adaptation of this Mallory design may solve the switch problem on your product, too.



COMBINATION TIMER AND PUSH BUTTON SWITCH

- Any combination of 5 circuits may be closed manually and then opened by the timer after any prescribed period of time.
- Timer control is designed for automatic operation within the limits of a 4 hour operating period.
- The switch is rated at 15 amperes and ¾ horsepower at 125 volts.
- The switch can be readily adapted for an infinite number of circuits up to 24 hours of time control operation.

This basic switch assembly is readily adaptable to a wide range of mechanical and electrical requirements, with or without the timer control unit. Mallory designs also include numerous other push button switches and interval timer switches that can be adapted to a wide variety of applications.

If you have a switch problem . . . on a product in production or one on the drawing board . . . call Mallory. A modification of an existing design may save you substantial engineering and tooling costs. Our engineers are always ready to work with you . . . give you the advantage of years of diversified experience in switch design and production.

Expect more . . .
Get more from **MALLORY**

Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For *plastic* Tooling, too

look to

NATIONAL LEAD COMPANY

"Nalco-Lite" *plastic* Die Set

Producing "leading edge corrugation parts" for aircraft with "Nalco-Lite" Plastic forming dies. This is one of 86 "Nalco-Lite" Plastic die sets, incased in Kirksite retainers, employed in aircraft parts production.

Kirksite Die & Engineering Department Now Set Up to Supply PRESS-PROVED DIES of "Nalco-Lite"* Plastic

If sheet metal stampings play a part in the manufacture of your product . . .

Then you will be interested in what the Kirksite Die and Engineering Department is doing with minimum-cost tooling for limited production or for tooling try-out runs.

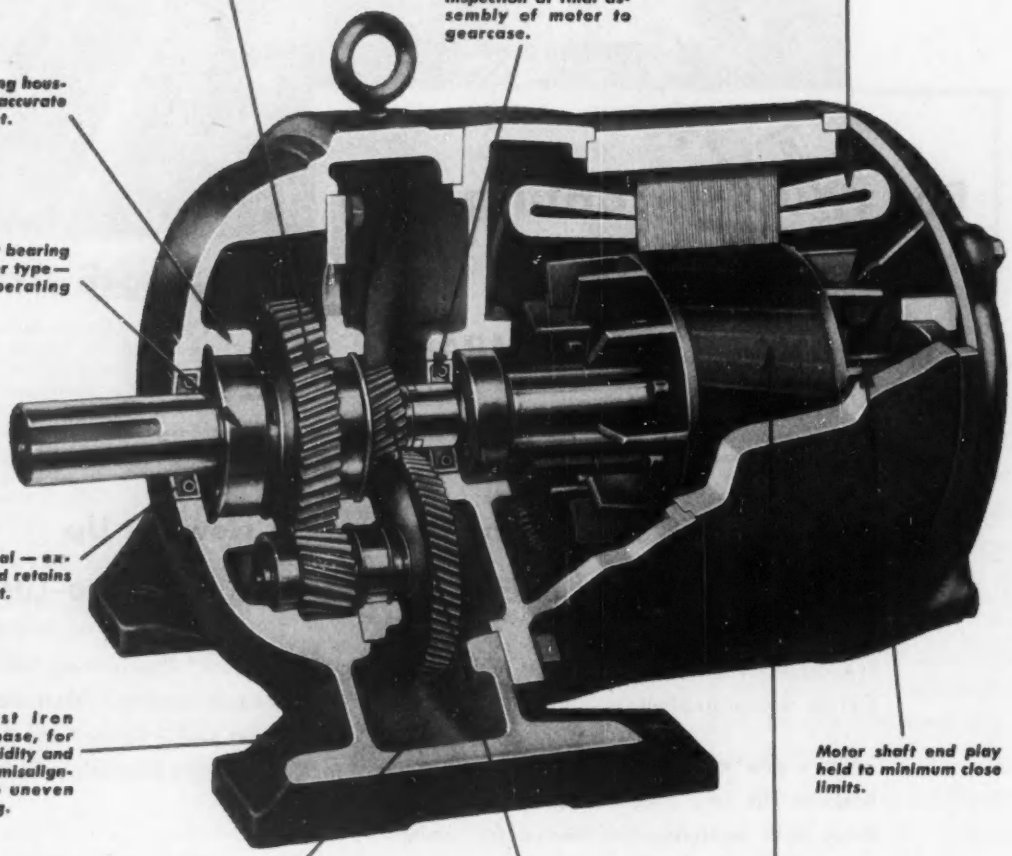
This newest development of Kirksite Tooling Service, "Nalco-Lite" Plastic, offers you press-proved dependability and economy for such tooling as stretch, form, hydropress and limited-production double action draw dies; master models and Keller and foundry patterns.

"Nalco-Lite" Plastic tools may be cast from standard-scale models . . . then used within a few days. Every tool is finished and proved . . . ready for action with a bare minimum of "barbering" required.

So, if you make automobiles, appliances, food handling equipment, office machines or any products using sheet metal construction, write for information on "Nalco-Lite" Plastic Tooling . . . giving as much detail as you can about the nature of your problem.

NATIONAL LEAD COMPANY
Kirksite Die and Engineering Department
900 West 18th Street, Chicago 80, Illinois
*Trademark

NEW GEARMOTOR by



Precision processed, file-hard gears for long wear and resistance to peak overloads.

Selected positive oil seal between gears and high-speed bearing. Lengthens bearing life by sealing off abrasive matter. No blind assembly—visual inspection at final assembly of motor to gearcase.

Properly insulated and carefully impregnated windings for maximum protection and long life.

Integral bearing housings maintain accurate gear alignment.

Extra capacity bearing —ball or roller type— for severe operating conditions.

Positive oil seal — excludes dirt and retains clean lubricant.

Rugged cast iron pyramidal base, for maximum rigidity and strength. No misalignment due to uneven foot mounting.

Motor shaft end play held to minimum close limits.

Large oil reservoir— efficient splash lubrication.

Locked motor shaft pinion provides positive contact for minimum vibration on reversing service.

Precision-balanced die-cast rotor.

W3-8

ELLIOTT CROCKER-WHEELER

Gives you the speed you want, where you want it—

In single reduction, 780 to 280 rpm... double reduction, 230 to 45 rpm... triple reduction, 37 to 7.5 rpm—

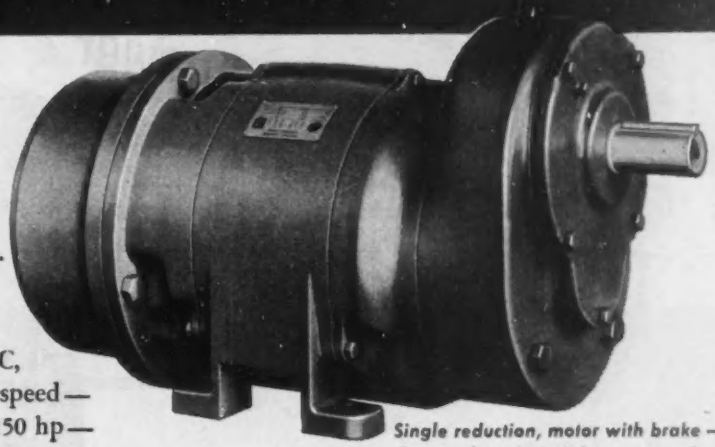
With any Crocker-Wheeler Motor—AC, squirrel-cage, wound rotor, DC, multi-speed—in the range of frame sizes from 1 to 150 hp—

In any closure type—open-protected, enclosed non-ventilated, splashproof, enclosed fan-cooled, explosion-proof—

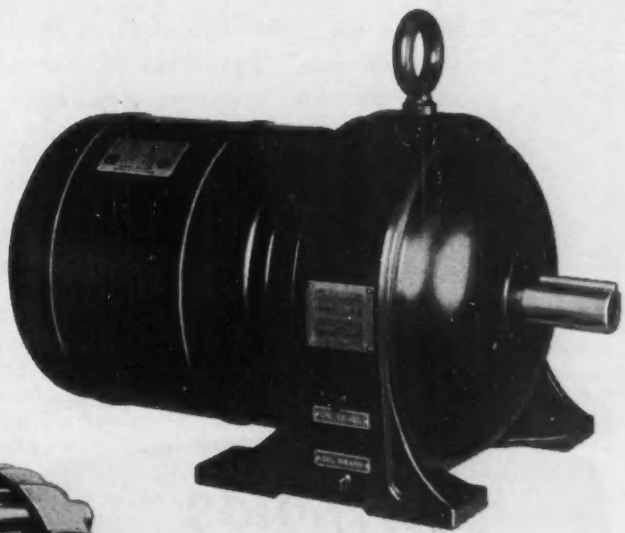
For any mounting required—horizontal, ceiling, sidewall, inclined—

Available also with the C-W disc brake, as a complete integral power unit—

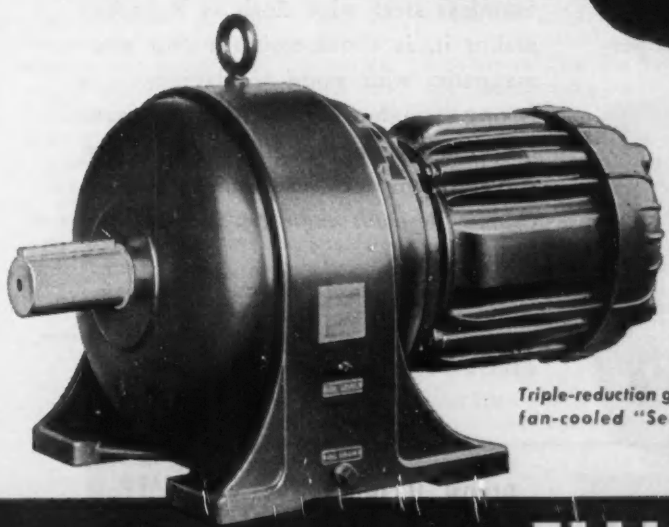
GET THE GEARMOTOR DATA BOOK
—ask your local Elliott District Office or write direct to Elliott Company, Crocker-Wheeler Division, Ampere, N. J.



Single reduction, motor with brake—A complete integral power unit—



C-W Form BA squirrel-cage motor with double-reduction gear—



Triple-reduction gear unit mounted on C-W totally-enclosed fan-cooled "Sealedpower" explosion-proof motor—

ELLIOTT Company
CROCKER-WHEELER DIVISION

wire cloth of MONEL or STAINLESS STEEL may be your answer

● Finding the right wire cloth to fit *precisely* the job it has to do in your product, means more than good quality and uniformity . . . more than the right type and size of wire, or mesh, or type of weave. It has to be right metallurgically and chemically . . . to prevent failures . . . to improve your product performance.

Reynolds stainless steel, or Monel metal cloth has a remarkable range of properties, in addition to resisting chemical and atmospheric corrosion. Stainless steel resists oxidation, and oxidizing solutions. It resists many acids; acid and alkaline salts; acetone, ethyl alcohol, benzene, chloroform, etc.

Stainless steel wire cloth as Reynolds makes it, is shock-resistant and non-magnetic, with good weldability . . . is strong enough to defy high temperatures and resist scaling; tough enough to take sub-zero temperatures to minus 320° F. *Consult Reynolds engineers.* No cost or obligation.

WIRE

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., **DIXON, ILLINOIS**

Divisions of National-Standard Co.

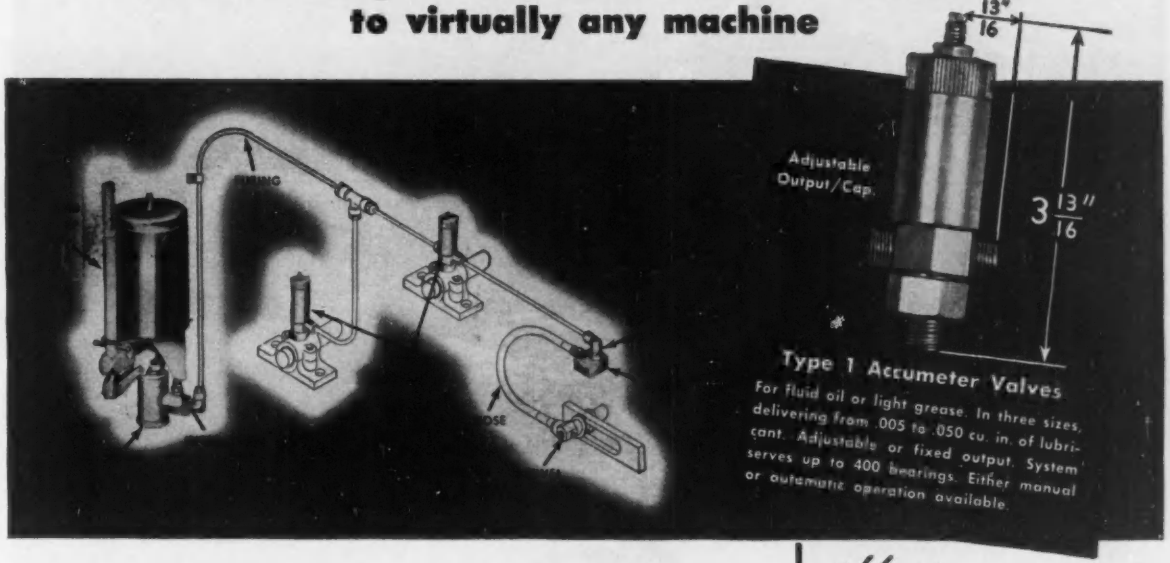
ATHENIA STEEL...*Clifton, N. J.* ..... Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.* ..... Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY...*Jersey City, N. J.* ..... Metal Decorating Equipment
WORCESTER WIRE WORKS...*Worcester, Mass.* .... Round and Shaped Steel Wire, Small Sizes

NS NATIONAL-STANDARD MILES, MICHIGAN

Designed... to eliminate hit-or-miss machine lubrication

ALEMITE Accumeter®
CENTRALIZED LUBRICATION

extends the protection of automatic lubrication to virtually any machine



Type 1 Accumeter Valves

For fluid oil or light grease. In three sizes, delivering from .005 to .050 cu. in. of lubricant. Adjustable or fixed output. System serves up to 400 bearings. Either manual or automatic operation available.

Centralized lubrication with Alemite Type I Accumeter can make your machines produce more, last longer, and cost less to run—*impressive savings at low cost!* This simple, single-line system is completely versatile—easy to design, easy to build into any machine because valves fit directly on bearings, replacing grease fittings, oil cups or reservoirs.

In seconds, in a fraction of the time required for hand lubrication, Alemite Accumeter Lubrication System delivers the exact, measured amount of clean oil or grease *from one central point* to all bearings of a machine. The machine keeps operating—no production time lost—no bearings are missed. No wonder 95% of big plants buying machine tools specify *centralized lubrication!*

Type 1 Accumeter Systems serve single machines or groups of machines with semi-automatic or fully automatic lubrication. It is just one of three types of Accumeter Systems made by Alemite to meet your exacting requirements.

offers...
ALL THESE ADVANTAGES!

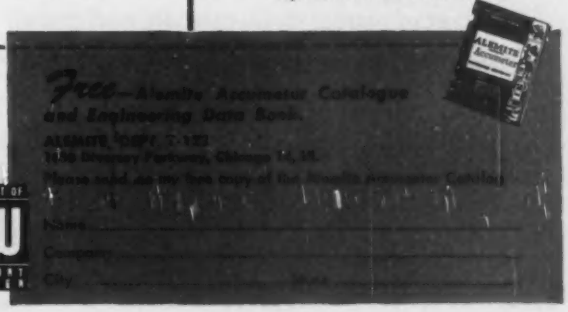
- **Eliminates shutdown time for lubrication. Adds productive time to machine output.**
- **Seals completely against dirt, grit, water all the way from "Barrel-to-Bearing."**
- **Prevents bearing troubles due to neglect or use of wrong lubricant.**
- **Services *all* bearings—including those inaccessible or dangerous—in one operation.**
- **Avoids work spoilage and bearing repairs due to over-lubrication.**

FACTORY-TESTED . . . FIELD-PROVED

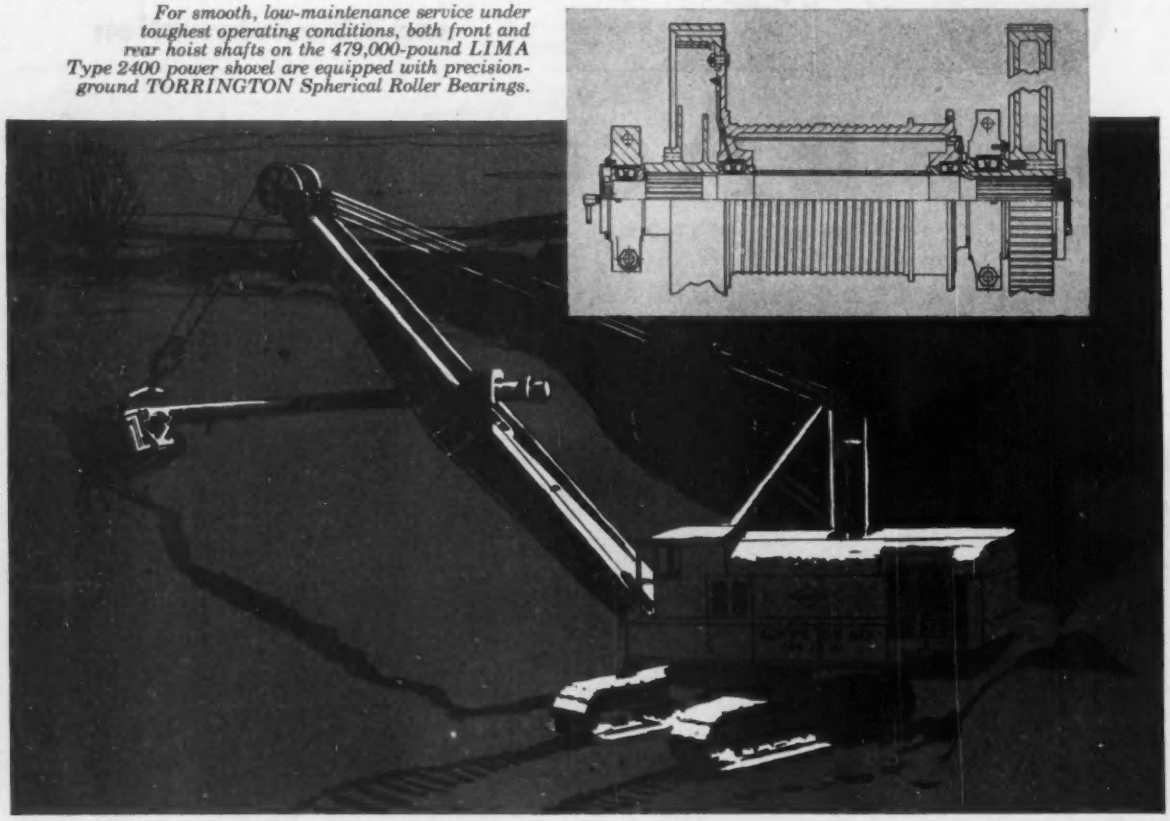
Proved in the field. Exhaustive tests showed *no variation* in the amount of lubricant discharged . . . even after 73,312 lubrication cycles, *equal to 122 years of twice-a-day service.*

ALEMITE
REG. U. S. PAT. OFF.

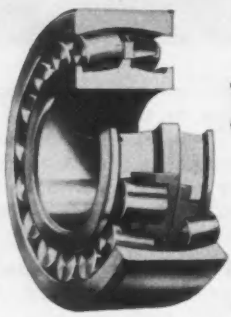
A PRODUCT OF SW STEWART-WARNER



For smooth, low-maintenance service under toughest operating conditions, both front and rear hoist shafts on the 479,000-pound LIMA Type 2400 power shovel are equipped with precision-ground TORRINGTON Spherical Roller Bearings.



Friction defeated!



Power delivered!

The bite of the bucket into solid earth may cause deflection, but TORRINGTON Spherical Roller Bearings, self-aligning and with high capacity, keep right on rolling. Power is constant and your shovel stays on the job.

These rugged friction fighters are made from the finest of bearing steels, carefully heat treated for maximum strength, toughness and resistance to wear. Both rollers and races are accurately manufactured for geometrical conformity and highest load-bearing capacity at all times. The solid ring, cast-bronze cages are *land-riding*.

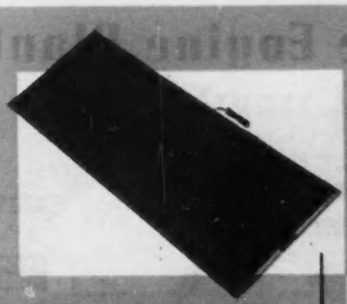
TORRINGTON Spherical Roller Bearings cut operating costs in the toughest of earth-moving and rock-processing applications. Prove it to yourself—specify TORRINGTON.

THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.

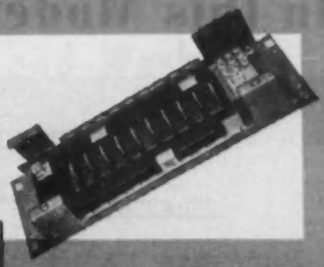
TORRINGTON SPHERICAL ROLLER BEARINGS

Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Rollers

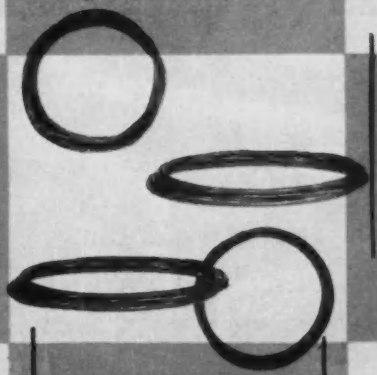
can your product be improved...



This carpet, molded of plastisols formulated from BAKELITE Vinyl Resins, contains electrical components. Step on it, and a door opens. Easily-molded, plastisol simplified placement of internal contacts. It's resistant to cleaning solutions, moisture, weathering and abrasion. Surface showed virtually no wear after six months in a busy supermarket. The Stanley Works, New Britain, Conn.

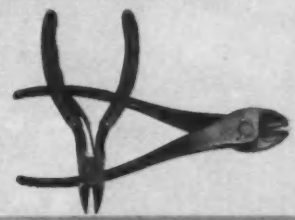


Potting insulation around the delicate copper conductors on this panel board was achieved with plastisols made from BAKELITE Vinyl Dispersion Resins. They flowed safely into place after the board was assembled. Baking fused them into a firm material with excellent electrical properties. It keeps conductors 10 per cent cooler than air does. By Trumbull Electric Dept., General Electric Co., Plainville, Conn.



Sleevings for electrical insulation are glass fiber coated with plastisols made from BAKELITE Vinyl Dispersion Resins. They stay flexible down to —65 deg. C., withstand continuous operation at 140 deg. C. They can be flexed, bent, twisted — without impairing dielectric value or rupturing. They are self-extinguishing, and resistant to moisture. By Suflex Corp., Woodside 77, N. Y.

A wire dish drainer, dip-coated with plastisols formulated from BAKELITE Vinyl Dispersion Resins, protects dishes and glassware, hushes clatter. It has a combination of bright colors. Its plastisol coating clings to the wire covering, softens joints and corners, stays resilient, yet firm. It's easy to keep clean. By Artistic Wire Products Co., Inc., East Hampton, Conn.



Tools can be cushioned by dip-coating their handles or molding BAKELITE Vinyl Dispersion Resin Plastisols to their jaws to help in holding wire. The plastisols hold fast to metal, withstand rough handling, abrasion, twisting and squeezing. Resilient, they give a better grip. Surfaces won't crack or peel. They resist oil, grease, chemicals, water. By Utica Drop Forge & Tool Corp., Utica, N. Y.

in this same way?

Data courtesy of Stanley Chemical Co., East Berlin, Conn.

Each product shown here had a problem in design or production—until BAKELITE Vinyl Dispersion Resins were used.

Each required a particular combination of properties — which BAKELITE Vinyl Dispersion Resins supplied.

Plastisols made from BAKELITE Vinyl Dispersion Resins, being fluid, are easily formed, quickly applied, rapidly cured to their finished state. They serve equally well for molding or dip-coating. They can be given a range of brilliant colors—surfaces that are glossy or soft-textured. They stay resilient, pliable, and tough — resist water, weather, acid and alkali solutions, greases and oils. They have good electrical properties.

These features add up to long wear and a wide variety of uses. They're the same qualities that fit BAKELITE Vinyl Resins and Plastics for scores of applications in defense and industry. For further information write Dept. PK-10.

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TRADE-MARK
VINYL RESINS

TRADE MARK
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A Division of
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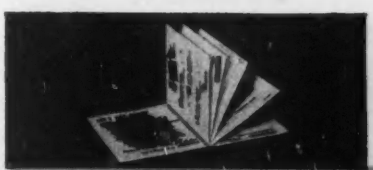
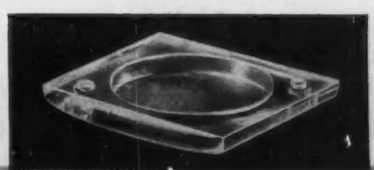


PROMOTION BOOKLETS with pages, covers and bindings made entirely of durable BAKELITE Rigid Vinyl Sheets stay clean and shiny, resist moisture, oil, grease, withstand handling for long periods. Printing is in perfect register. By Mapp Press, New York, N. Y.



PROTECTIVE COVER for bubble glass on spirit level is made of BAKELITE C-11 plastic. Transparent and strong, it provides attractive appearance, high mechanical strength, less chance of breakage. By National Lock Co., Rockford, Ill., for Empire Level Mfg. Co., Milwaukee, Wis.

FORMING DIE for metals is made of densified wood—laminated veneers impregnated under pressure with BAKELITE Phenolic Resins. It offers high impact strength, light weight, ease of repair, economy. Easily machined. By Formica Co., Cincinnati, O.

In this Modern Automobile Engine Plant

Wherever you look.....

you'll see VICKERS® HYDRAULICS

Here is a scale model of the production line area of one of the most modern automobile engine plants ever built. Having a capacity of 100 V8 engines per hour, it is equipped with time-and-money-saving machinery for automation.

Wherever you look in this plant you'll see Vickers Hydraulics. This is indicated on the photograph by the lines leading out from the Vickers-equipped machines to the names of their makers. It is an interesting study . . . first for the variety of machines . . . second for the large number of builders who use Vickers Hydraulics. Vickers Hydraulics is often the ideal solution to the myriad problems of feed, control, transfer, synchronization, etc. which must be dealt with in a highly automatized plant such as this. Hydraulic power can be developed wherever most convenient and applied at any other location. Simplification of design, flexibility of control, instantaneous response, rapid operation, ease of providing interlocks and overload protection, low maintenance . . . all are characteristics of Vickers Hydraulic Systems.

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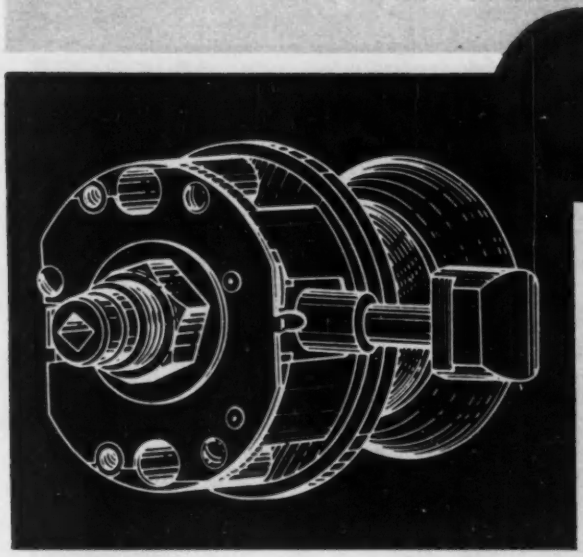
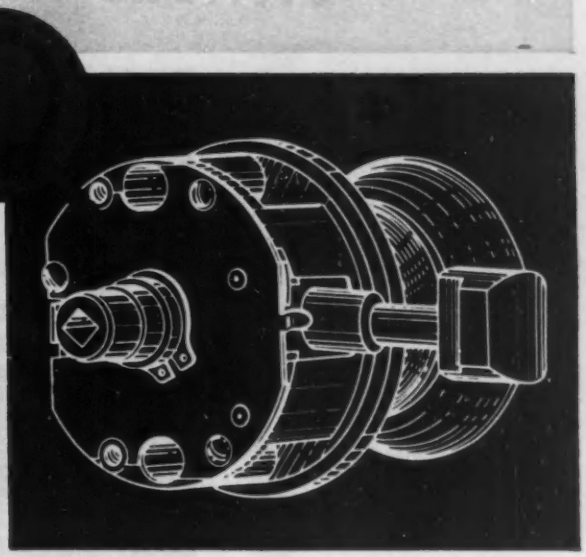
Waldes Truarc Ring Replaces Nut and Washer ...Cuts Costs $5.28 Per M...Speeds Assembly by 50%



OLD WAY. Main shaft required costly threading. Assembly was slowed by the double application of washer and nut and time-consuming tightening operation.



TRUARC WAY. Truarc Retaining Ring snaps quickly and simply over shaft. Lock assembly is secured in one fast operation. Virtually all play is eliminated from lock.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS

OLD WAY

Cost of Nut	$10.00	per *thousand*
Cost of Washer	3.80	" "
Labor for Threading	2.00	" "
Assembly	3.00	" "
TOTAL	$18.80	

TRUARC WAY

Cost of Truarc Ring and Grooving Operation	$11.52	per *thousand*
Assembly	2.00	" "
TOTAL	$13.52	

J. Chesler and Sons, Inc., Brooklyn, N.Y., manufacturers of the pre-assembled "Reddi-Mount" cylindrical lockset, uses a single Waldes Truarc Retaining Ring instead of an old fashioned nut and washer to secure the entire assembly of their lock. This new, improved fastening method enables Chesler to eliminate costly threading . . . save money on material . . . speed assembly time by 50% and produce an improved, more durable product.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble.

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PN125

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Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

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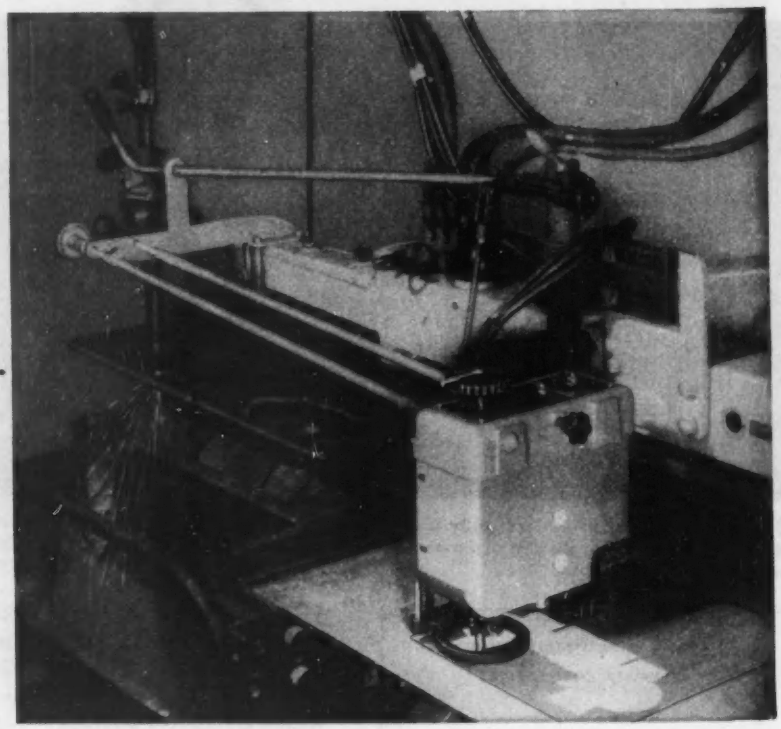

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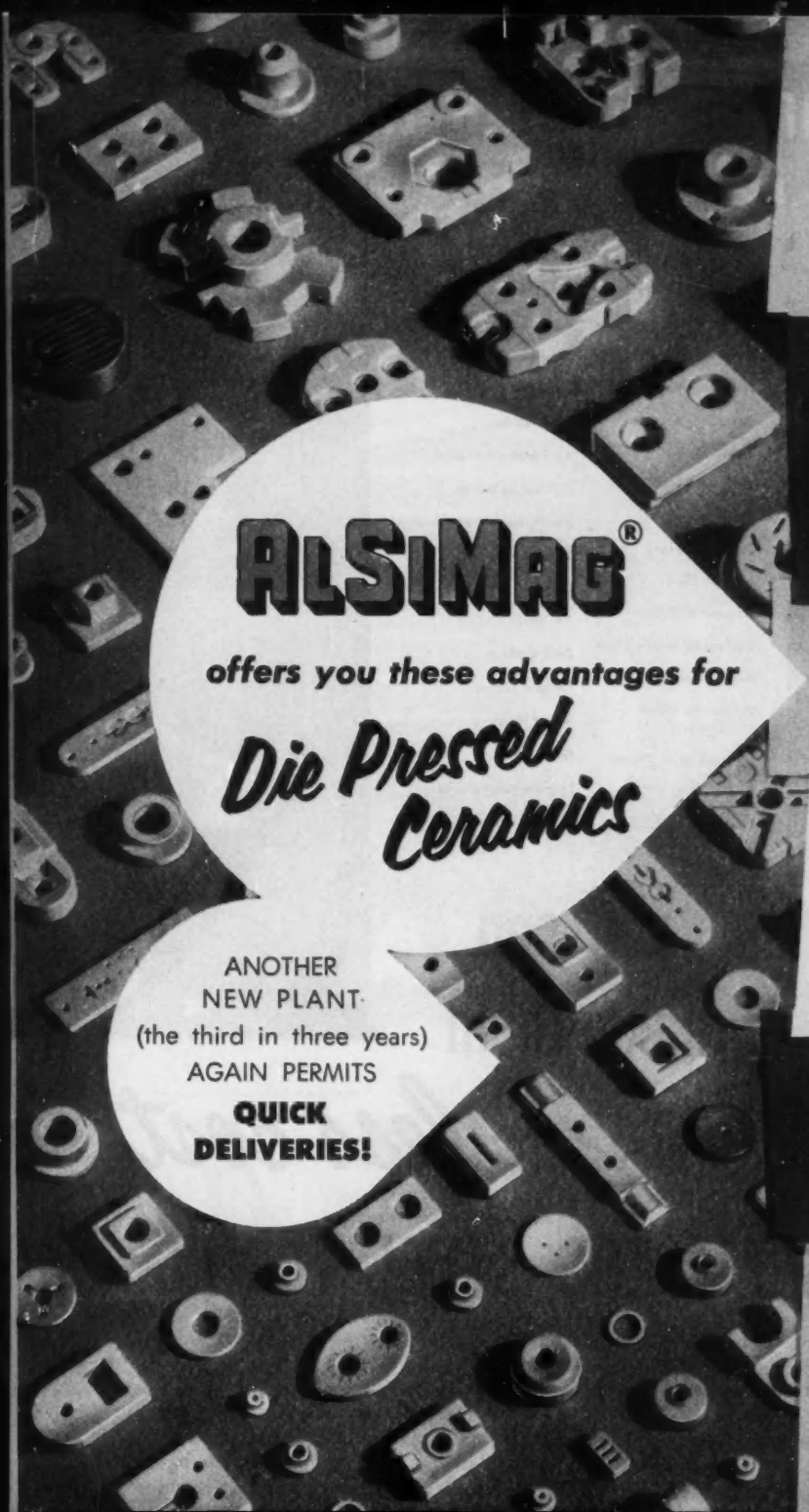

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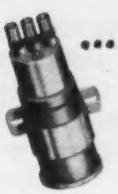

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The small change is that of specifying Carpenter Stainless Tubing rather than just "stainless tubing" . . . the folding money is attested by the captions under the pictures at the left.

What is more important to you, however, is the fact that none of the orders were for "specials" . . . all of these pieces were made from "mill run" tubing as delivered by Carpenter.

The moral of the story is, of course, that there *is* a difference in Stainless Tubing—and Carpenter makes it. Why not make the most of this *provable* difference in your own shop—for your own profit. Call your nearest Carpenter Distributor for your next order of tubing . . . plus design and engineering help if you need it. "One Call Does It All."

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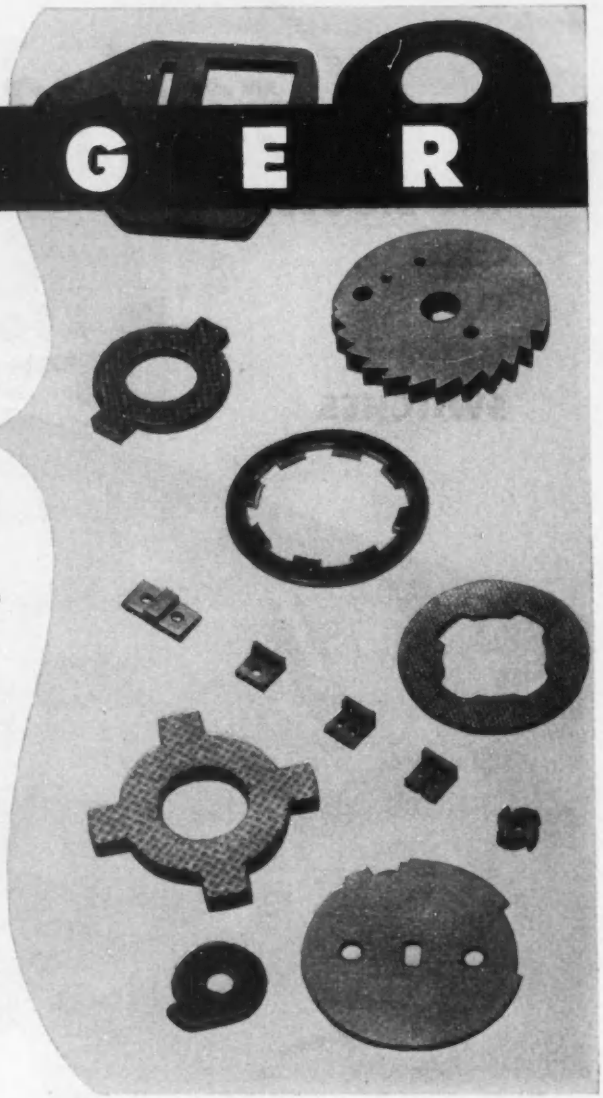

Components fabricated by Spaulding to your specifications from Spaulding basic materials offer great ***resistance to wear*** in a wide variety of combinations with such other properties as structural strength, dimensional stability, light weight, electrical insulation, moisture resistance, resistance to chemicals, clean machining, and quietness in mechanical operation.

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Write our Redwood City office for reprints of this Logbook page

Sealing News & Tips

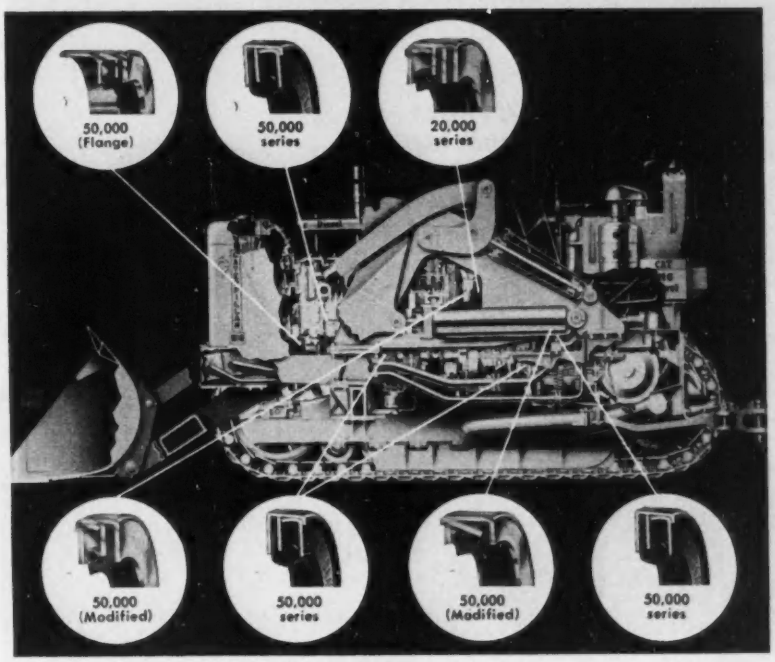


Figure 1. Caterpillar No. 6 Shovel

National Oil Seals used at key points throughout new Caterpillar No. 6 Shovel

The Caterpillar No. 6 Shovel is a 66 hp heavy-duty unit of two-yard capacity, with a non-oscillating track frame. As in other Caterpillar equipment, National Oil Seals are installed at key points to retain lubricant, exclude dirt and water, and prolong life of bearings and assemblies.

Among the many positions where National seals are installed is the front crankshaft bearing. Here a National 50,000 series seal with a special, press-fit mounting sleeve is employed. This seal is of single-lip design, and has an accurately spring-tensioned leather sealing member to retain crankcase oil.

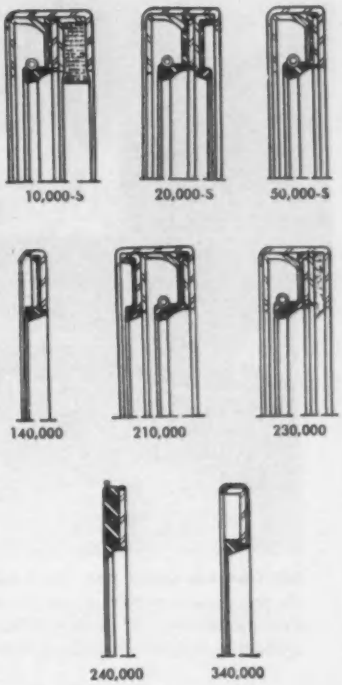
On the fuel pump shaft, Caterpillar also uses a National 50,000 seal with a spring-tensioned leather sealing lip. On the starting engine crankshaft (rear) a National 20,000 series seal is used. This is a dual-lip seal, employing a leather main sealing lip to retain lubricant and a springless leather auxiliary lip as a dust excluder.

At other vital positions, including the starting engine crankshaft (front), track carrier rollers, the upper transmission shaft, gear shifter shaft and shaft housing, modified or standard-design National 50,000 series leather seals are employed. National precision shims are also utilized extensively in the shovel, and National O-Rings are used in the steering clutch control and dump control assemblies.

National seals used in the Caterpillar No. 6 Shovel are all basic designs or modifications. National offers over 2,500 standard-design seals; can also provide special seals for special requirements. Your National Field Applications Engineer has complete information.

*T. M. Reg.

National Syntech* Oil Seals are widely used for operation in applications where intermittent temperatures reach 250° F, speeds reach 3,600 F.P.M., and total indicator runout reaches .030. Basic designs shown here employ tough, accurately manufactured steel outer cases, precision-tensioned springs and accurately molded and trimmed Syntech sealing lips unaffected by water, most lubricants, detergents or industrial fluids.



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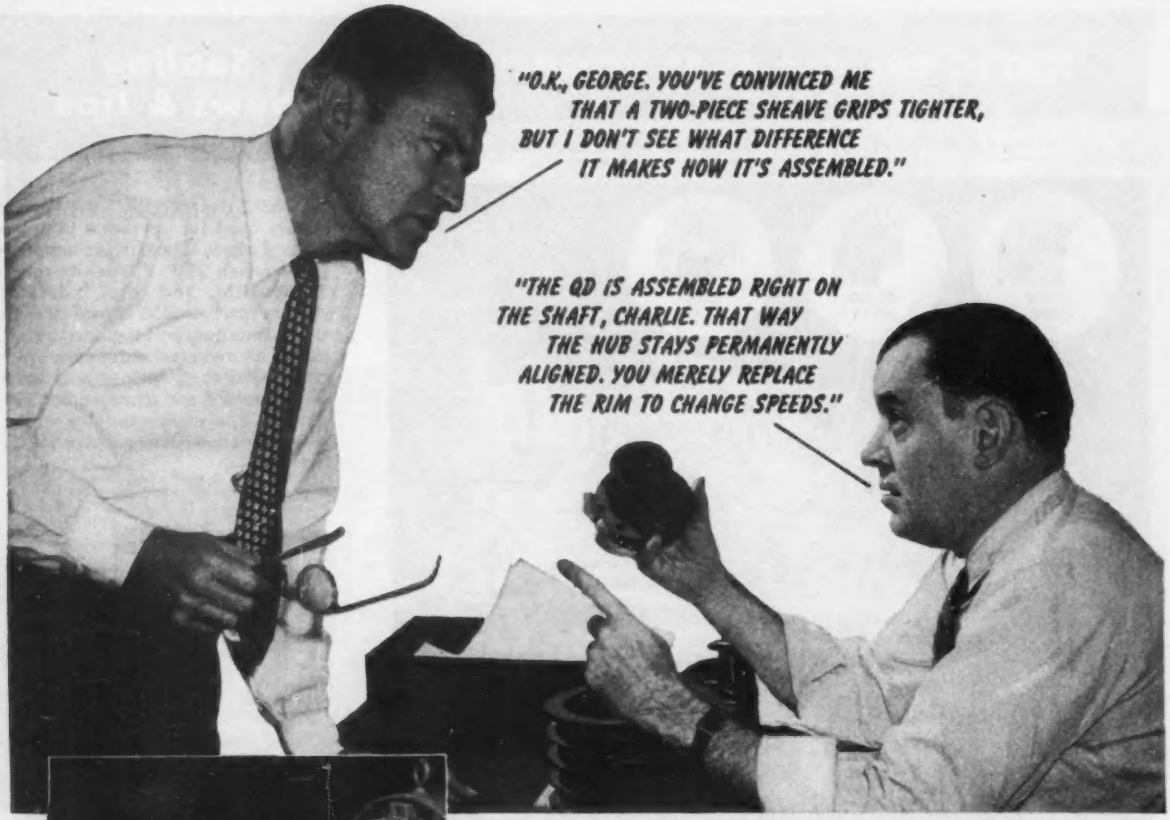
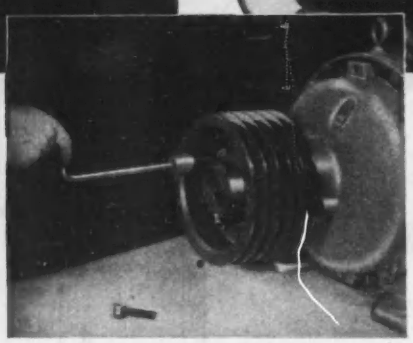
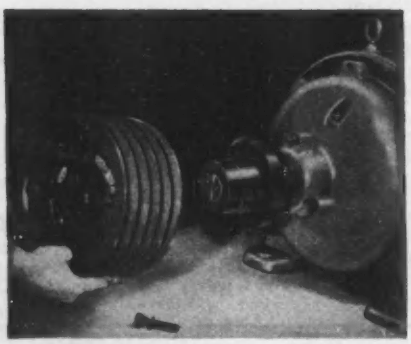

"O.K., GEORGE. YOU'VE CONVINCED ME THAT A TWO-PIECE SHEAVE GRIPS TIGHTER, BUT I DON'T SEE WHAT DIFFERENCE IT MAKES HOW IT'S ASSEMBLED."
"THE QD IS ASSEMBLED RIGHT ON THE SHAFT, CHARLIE. THAT WAY THE HUB STAYS PERMANENTLY ALIGNED. YOU MERELY REPLACE THE RIM TO CHANGE SPEEDS."



ONLY THE RIM COMES OFF. This is done by using the heavy assembly bolts as jack screws. Then the sheave slides easily off the tapered hub. No time-consuming prying or hammering is required.

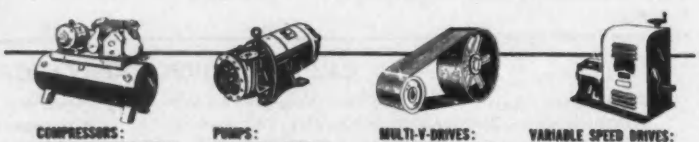


THE HUB STAYS PUT—there's no need to remove it when changing speeds. When you've finished the job, you just replace the rim over it and tighten the bolts. Alignment is *permanent*.

"How it's assembled" makes a big difference when you're choosing sheaves!

Because the famous Worthington QD can be assembled and disassembled right *on the shaft*, your maintenance man can change speeds merely by changing rims. The previously aligned hub need not be touched.

On initial assembly, holding alignment of the hub is a snap. All you do is tighten the flange cap screw after positioning the hub along the shaft. Drifting of the key is prevented by tightening the set screw over the key.

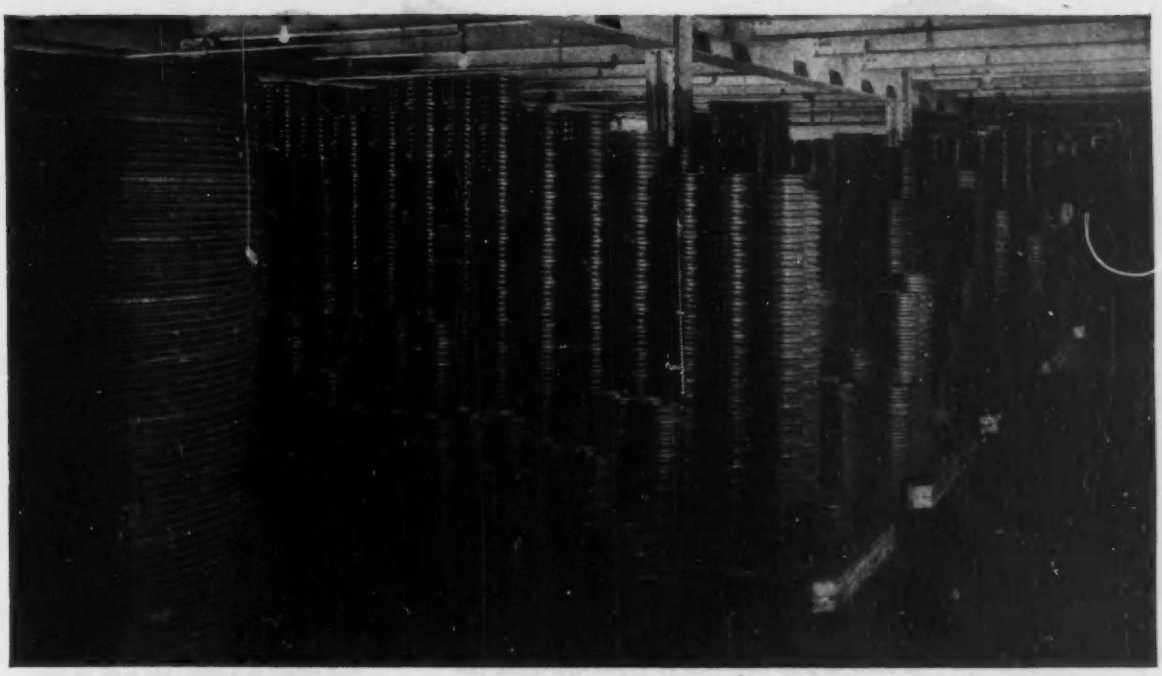


COMPRESSORS: AIR-COOLED, WATER-COOLED

PUMPS: CENTRIFUGAL, ROTARY, STEAM, POWER

MULTI-V-DRIVES: QD SHEAVES AND V-BELTS

VARIABLE SPEED DRIVES: WORTHINGTON ALLSPEED



You don't have to wait for Multi-V-Drive Equipment

WORTHINGTON-GOODYEAR EC CORD V-BELTS are the only belts available with a single parallel row of low-stretch, high tensile, heavy cord to withstand high flexing abuses required of short belts. Tire cord ply construction insures proper transverse rigidity on longer V-belt drives. Steel Cable V-belts and HY-T Super Rated V-belts will handle really tough drives. Prompt service on the complete line.

Worthington stocks a complete line of QD Sheaves, small V-pulleys, and Worthington-Goodyear EC Cord V-belts

Your local Worthington Multi-V-Drive distributor has a complete line of Worthington QD Sheaves, fractional horsepower V-pulleys and Worthington-Goodyear V-belts. He's backed by large factory stocks that enable him to fill your order *immediately*.

The Worthington fractional horsepower line of V-pulleys includes:

The QD Junior V-Pulley that will grip the shaft tighter than any other V-pulley now available. Its tapered hub is forced tight on the shaft and won't loosen due to shock or vibration.

Machined Steel V-Pulleys—3½ inches and under—precision-bored for proper fit. Grooves are accurately cut to provide proper seating of the belt for longer wear.

Pressed Steel V-Pulleys of heavy gauge welded steel. Equal weight distribution assures accurate balance and vibrationless operation.

Cast Iron Bored-to-Suit V-pulleys accurately machined for true running and perfect balance. They come in a full range of sizes with one or two grooves.

For prompt deliveries, or further information on any Multi-V-Drive equipment, write to Worthington Corporation, Section MV.3.2, Oil City, Pennsylvania.

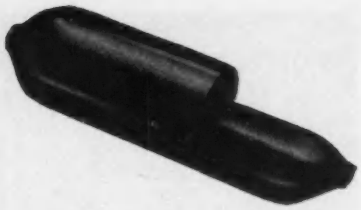
MV.3.2

Specify These Worthington Standard Products on Your Equipment

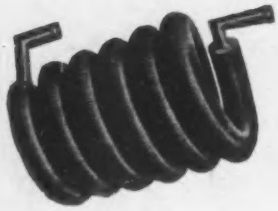
WORTHINGTON

This flat pancake type coil, measuring 9" across, contains 5½ feet of Wolverine Trufin*—the integral finned tube—in its 3½ turns.

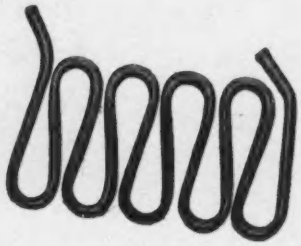
Shown here is a heat exchanger containing 25" of Wolverine Trufin* coiled within a 2½" O.D. copper shell whose ends have been reduced by the Wolverine Spun End Process†. This is a good demonstration of the ease with which Trufin can be fabricated.



A simple form fabricated from seamless copper tube, utilizing the Wolverine Spun End† Process. By producing the part this way, you enhance its appearance—effect many economies and in most cases, eliminate "extra-part" assemblies.



The illustration on the left shows how Trufin may be coiled as easily as plain tube. Pictured to the right is one coil nested inside the other. The finished coil is approximately one foot high and 5" in diameter; the total length of the tube is 63 feet.



This shows serpentine coil to get maximum length in a small space, all on one plane. Both ends have been beaded to facilitate hose connections.

Are you about to design a Tubular Part?

In designing a tubular part, which will become a component of your main product, what will you strive for? Attractive form? Speed in production? Economy?

Wolverine can help you at every turn.

Wolverine has the skill and necessary equipment to produce nearly any tubular shape you specify—in copper, copper-base alloy, or aluminum.

In collaboration with its customers, Wolverine has designed many tubular parts which have effected increased efficiency and worthwhile savings. The product was re-designed so it could be made in a fraction of the time previously required.

Additional economy was also realized in a reduction of component parts needed, which resulted in reductions in assembly time.

You should get many helpful suggestions from our Fabricated Parts Book. We will be glad to send it to you on request.

*REG. U. S. PAT. OFF
†A PATENTED PROCESS RE. 22465

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.

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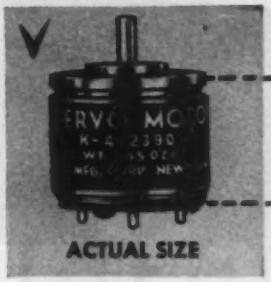
EXPORT DEPT. 13 E. 40th St. New York 16, N. Y.

TYPICAL CHARACTERISTICS

MECHANICAL DATA		ELECTRICAL DATA	
Weight	1.45 oz.	No load speed	6,500 RPM
Rotor inertia	.46 gm-cm²	Stall torque	.3 oz.-in.
Theoretical acceleration	49,000 RAD/SEC²	Maximum output	.490 W.
		Single phasing	None

DATA AT STALL	FIXED PHASE	CONTROL PHASE
Voltage (volts)	26	26
Frequency (cycles)	400	400
Current (ma.)	166	166
Power input (watts)	3.1	3.1
Power factor	.63	.63
R—ohms	98.5	98.5
X—ohms	123	123
Z—ohms	157	157

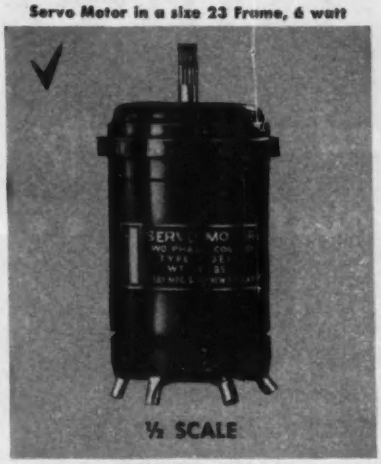


ACTUAL SIZE

Servo Motor the size of a Penny

Ketay's Experience helps you

Servo Motor in a size 23 Frame, 6 watt



½ SCALE

TYPICAL CHARACTERISTICS

MECHANICAL DATA		ELECTRICAL DATA	
Weight	1.6 lbs.	No load speed	3,500 RPM
Rotor inertia	20.0 gm-cm²	Stall torque	7.5 oz.-in.
Theoretical acceleration	26,500 RAD/SEC²	Maximum output	6.0 W.
		Single phasing	None

DATA AT STALL	FIXED PHASE	CONTROL PHASE Series	CONTROL PHASE Parallel
Voltage (volts)	115	115	57.5
Frequency (cycles)	60	60	60
Current (ma.)	175	175	350
Power input (watts)	14.0	14.0	14.0
Power factor	0.70	0.70	0.70
R—ohms	460	460	115
X—ohms	470	470	117
Z—ohms	660	660	164

Also for 115V or 230V operation on control phase.

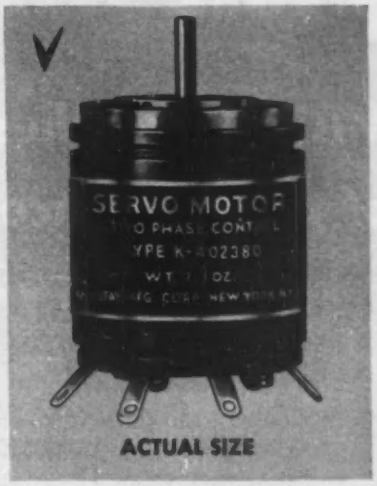
Check these Servo Motors against your needs

Ketay offers a complete line of high precision **SYNCHROS, SERVO MOTORS and RESOLVERS.**

Ketay's experience also includes: automatic control devices for use in fire control and missile systems; computers and simulators; amplifiers; marine inter-communication equipment; remote indicators such as ship course indicators, drive angle indicators and salinity indicators; and automatic control systems.

Mail coupon today for bulletin containing specifications on 100 types of Synchros, Servo Motors and Resolvers.

Servo Motor in a size 15 Frame, 60 cycle, 115 volt



ACTUAL SIZE

TYPICAL CHARACTERISTICS

MECHANICAL DATA		ELECTRICAL DATA	
Weight	7.3 oz.	No load speed	3,300 RPM
Rotor inertia	3.03 gm-cm²	Stall torque	1.45 oz.-in.
Theoretical acceleration	33,800 RAD/SEC²	Maximum output	1.23 W.
		Single phasing	None

DATA AT STALL	FIXED PHASE	CONTROL PHASE Series	CONTROL PHASE Parallel
Voltage (volts)	115	115	57.5
Frequency (cycles)	60	60	60
Current (ma.)	53	53	106
Power input (watts)	5.0	5.0	5.0
Power factor	.82	.82	.82
R—ohms	1780	1780	445
X—ohms	1240	1240	310
Z—ohms	2170	2170	542

Ketay

DESIGN
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... of precision instruments components, systems.

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Electronic Instrument Division • Research & Development Division

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Why designers of precision products pick MICRO switches

MICRO switches offer unequalled uniformity of performance such products must have • • • • • •

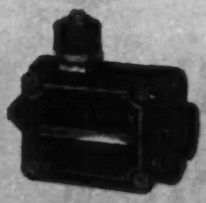
• **MICRO** precision switches have always been first choice of designers of products where even slight deviation from precisely set limits cannot be tolerated.

Design engineers of such concerns as American Optical Company and Jones and Lamson are typical of this choice of **MICRO** switches as components of equipment whose functions depend on extreme accuracy, absolute dependability and freedom from maintenance.

If your work involves design of products where only switch components of unquestioned uniformity can meet specifications, **MICRO** switch is your answer. Over 6000 different types of these small, precise, snap-action switches have been developed to meet such requirements. Perhaps one of these will meet your specifications. If not, **MICRO** engineering, both in the field and at the factory will cooperate with you to develop a new switch that will. A call to the nearest **MICRO** branch can save you time and money. Why not do it today?

MICRO
MAKERS OF PRECISION SWITCHES
FREEPORT, ILLINOIS

A DIVISION OF
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY



Two MICRO switches speed operation of Jones and Lamson Comparators which "see" size, shape and fit of small parts

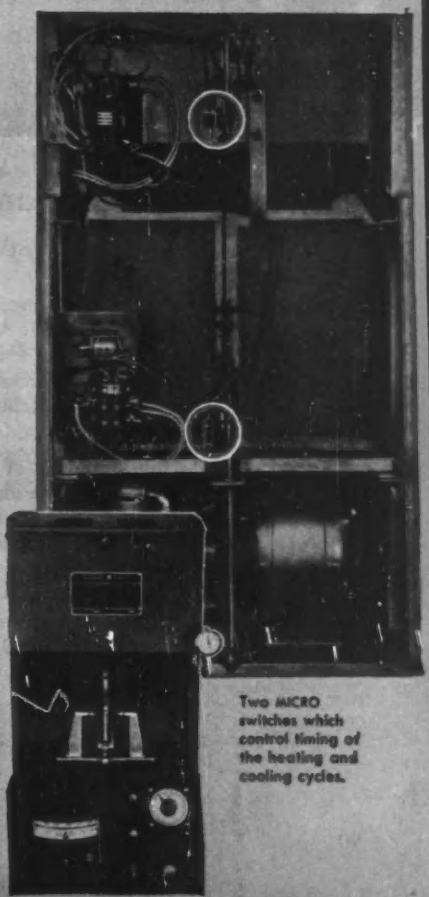
Two MICRO switches which control the upper and lower limits of the power elevator.

• Visual inspection now checks measurement of small parts faster and more accurately than ever before. This process has been speeded 50% and more by the use of the new power elevator on Jones and Lamson optical comparators, which gives finger-tip control to the vertical traverse.

Two MICRO switches help make this operation faster, safer and more automatic by making it impossible for the table to raise or lower beyond previously adjusted limits. This leaves the operator free to position his work quickly without fear of damage to the machine.

These switches are particularly well-suited to this purpose because of their quick and dependable response, their enclosed housings with sealed plungers to resist entrance of dirt or dust and their convenient mounting and wiring arrangements.

American Optical Company's engineers chose four MICRO switches to control precision lens heat-treating unit



Two MICRO switches which control timing of the heating and cooling cycles.

• A toughening process which enables ophthalmic and safety lenses to withstand far greater impact than untreated lenses has been developed by engineers of American Optical Company. It makes use of precision techniques which require the utmost in sensitive, accurate controls.

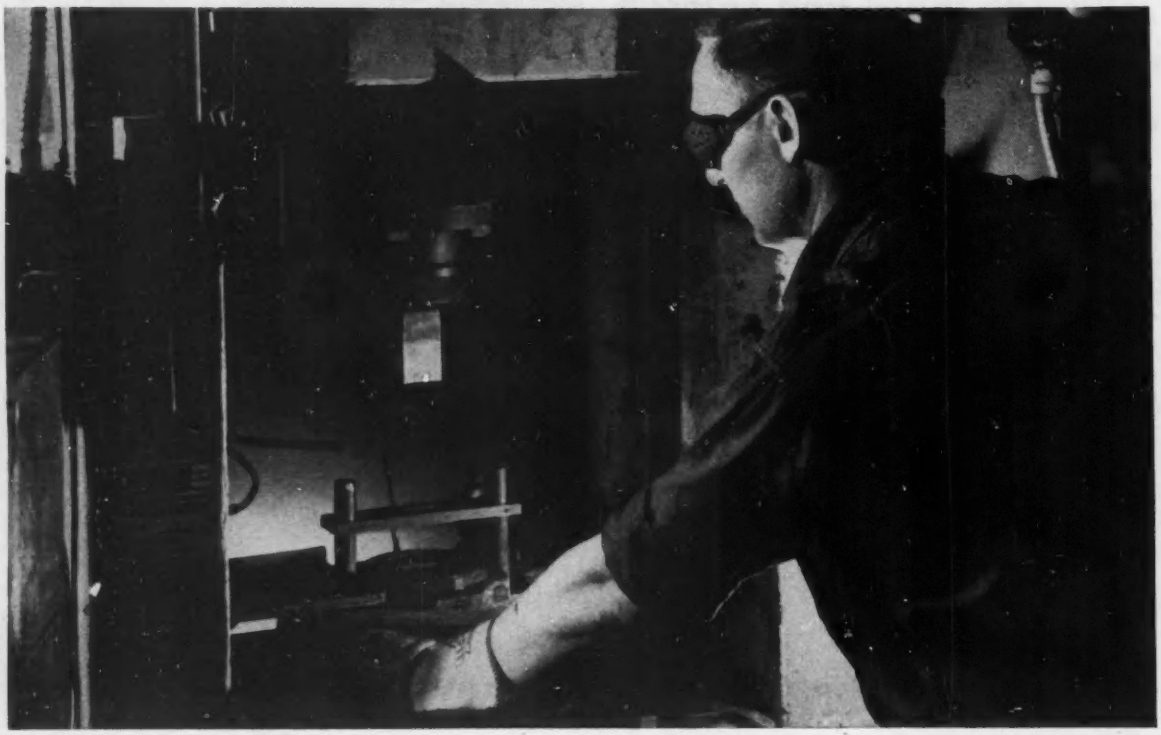
MICRO switches were selected to control the timing of the heating and cooling cycles because of their:

- **Long-life characteristics**
- **Low operating force**
- **Dependability of performance**
- **Sufficient electrical capacity to control the two solenoid valves and air pump motor**

Here again MICRO switches prove their worth as components of equipment where failure is intolerable. These heat-treating units must work day after day with minimum maintenance if production is to proceed smoothly in American Optical plants in this country and abroad.

DOW

IMPACT EXTRUSIONS ARE NOW POSSIBLE IN MAGNESIUM



Savings in tooling and materials handling plus single-step operation assures substantial cost reductions.

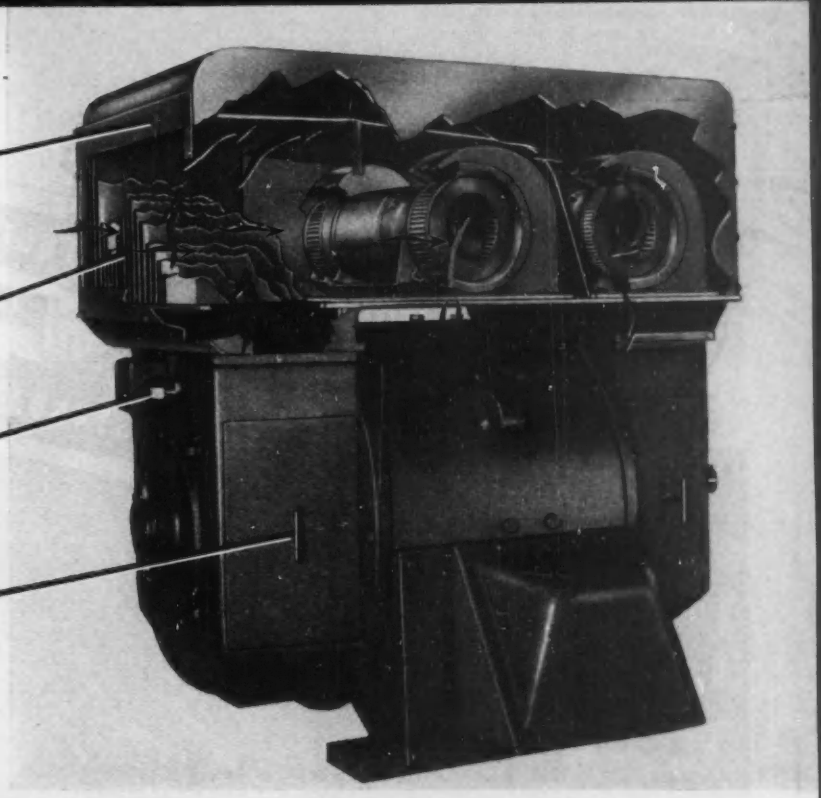
The newest technological advancement in the fabrication of *magnesium* is impact extrusion. As a result, it is now possible for more industries than ever before to take full advantage not only of the remarkable qualities of the world's lightest structural metal, but also of the many benefits of impact extrusions.

Here, for example, are just a few of the advantages magnesium impact extrusions provide: (1) Larger parts and more intricate shapes can be impact extruded with less pressure than required for other metals. (2) Impact extrusion die life is extremely good. Many thousands of parts have been made on a single set of dies. (3) Parts can be made in a one-step operation, instead of a sequence of steps required by other methods. (4) More impact extrusions can be made from a pound of magnesium than from a pound of any other metal.

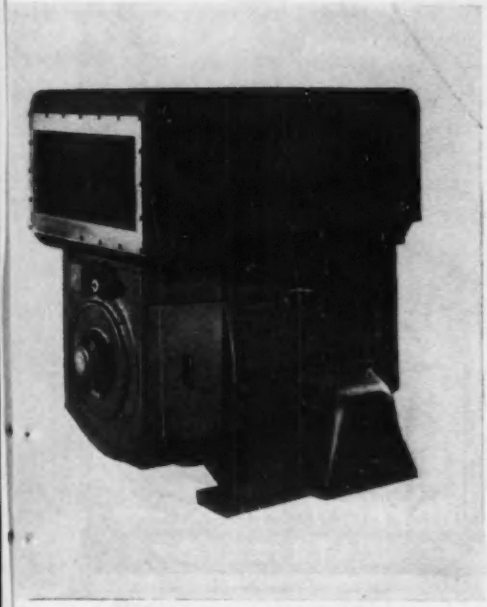
In addition to the advantages of the process, magnesium contributes its own properties which make it exceptionally useful wherever strength and light weight are design factors. It's one-third lighter than aluminum. It's strong and rigid. It has excellent resistance to many organic chemicals and oils. It possesses good electrical conductivity.

Why not consider magnesium impact extrusions to help reduce your costs . . . to help boost your production . . . to help solve your problems. For more data pertaining to your operations, write to us directly. THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan.

you can depend on DOW MAGNESIUM DOW


COMPACT, top-mounted cooling unit falls within the over-all length and width of main motor.
SMOOTH vertical plates are self-cleaning. Cooling unit is easy to remove for inspection.
PROTECTIVE THERMOSTAT helps safeguard main motor in case of blower-motor power failure.
EASY ACCESS to inspection opening—no tools required.

General Electric Announces New Unit-Cooled D-C Motor!



THE SMOOTH STYLING of the new unit-cooled motor is in harmony with good machine design. Smooth contours facilitate cleaning. No ducts or piping are needed on this compact, ready-to-install unit.

Smallest of type from 15-200 hp, new motor features 50% greater heat transfer in 37% smaller unit than previous design.

To meet your industry's need for a compact, totally enclosed motor, this new General Electric unit-cooled design features more effective heat transfer in a smaller unit.

Special construction assures dependable operation, with minimum maintenance, in the severe atmospheres which make open or partially enclosed motors difficult to maintain.

Shutdowns for cleaning and inspection are reduced to a minimum. Air-borne contaminants and foreign particles are kept out of the internal ventilating air by the totally enclosed construction

For additional information on ratings and dimensions, contact your nearest General Electric office or write for Bulletin GEA-6091, "Unit-cooled D-C Motors." Address Section 770-31, General Electric Company, Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

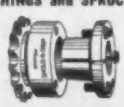
means approval by 250,000 cost-wise buyers

EQUIPPED WITH BOSTON Gear STANDARDIZED PRODUCTS

STOCK GEARS — 2000 TYPES and SIZES

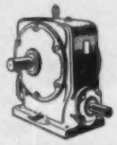
SPROCKETS and CHAIN

SHOLD-A-GRIP Interchangeable Tapered BUSHINGS and SPROCKETS



RATIOMOTORS

REDUCTORS



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UNIVERSAL JOINTS

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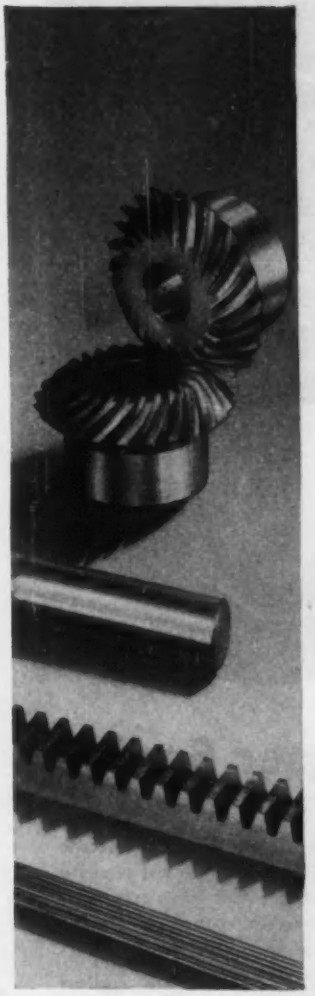
Gives your product preferred rating

...the lift that swings more sales



It makes sense to team up with the leader.
Choose BOSTON STANDARD STOCK gears and related drive components for your product. Here's why:

1. **LEADING SPECIALISTS** in standardized machine drive parts for 75 years.
2. **LARGEST PRODUCTION** facilities, serving 250,000 customers in all industries.
3. **HIGHEST QUALITY.** Assures immediate interchangeability, anytime, anywhere.
4. **LOWER COST** Longest service life assured by BOSTON Gear quality.
5. **5112 STOCK ITEMS** Broadest range of standard styles and sizes.
6. **NEARBY STOCKS,** at leading supply centers . . . the nation-wide network of 92 BOSTON Gear Distributors . . . with stocks totaling $10,000,000.

These are more than advantages . . . they are *essentials* to trouble-free planning and servicing of any product assembled with standardized parts. Only BOSTON Gear offers them *all.* Compare — and you'll agree — it pays to "Design around BOSTON Gear".

For information on any product, see your nearby Distributor. When desired, he'll arrange consultation with a BOSTON Gear Field Engineer. Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

BOST-BRONZ Oil-Impregnated BEARINGS

Get Catalog No. 55
Industry's most valued "textbook" of drive design and maintenance . . . includes 30 pages of Engineering data.

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FOR PROMPT DELIVERIES AT FACTORY PRICES

BALL BEARINGS

Look under "Gears" in the Yellow Classified Section of your Telephone Directory for the BOSTON Gear Distributor nearest you.

2 High Hot Strip Mill Table Rolls in plant of Dominion Foundries and Steel Ltd., Hamilton, Ontario, Canada. Arrows indicate location of J-M Clipper Oil Seals which protect bearings against dirt and other adverse conditions.

Engineers at Dominion Foundries and Steel Hot Strip Mill report:

"Bearings better protected— damaging dirt sealed out with Clipper Seals"

TABLE ROLLS of the 2 high strip mill at Dominion Foundries and Steel Ltd. must operate efficiently despite severe service conditions. Life of the Roll Bearings is constantly threatened by dirt and salt from strip mill operations.

To provide better protection, engineers replaced the original bearing seals with J-M Clipper Oil Seals. Long after this installation was made, Clipper Oil Seals are still providing far better bearing protection than the material formerly used. They seal out mill scale, salt and other foreign matter which might work into the bearing housings. They remain efficient despite high oil and air temperatures. They protect bearings by assuring clean lubrication.

Clipper Oil Seals offer many advantages wherever accurate fit, longer life and greater sealing effectiveness are required. These precision-moulded oil seals provide easy installation because the tough, dense heel affords just the right amount of rigidity for a press fit in the cavity . . . while the flexible lip, held in light but positive contact with the shaft by an especially designed garter spring, provides effective sealing at all times.

Made in both split and endless types, Clipper Oil Seals are available in a wide variety of designs, to meet practically any sealing requirement. For complete details and literature write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

JOHNS-MANVILLE JM PRODUCT

Johns-Manville CLIPPER OIL SEALS

Jack the Giant Killer

Jack found the best way to slay the giant was with a sharp axe. The solution to industry's giant problem — cutting production costs — involves using a great many axes. One way to help conquer *this* giant is to substitute small equipment capable of doing a big job.

Eastern HYDRAULIC PUMPS and FLUID MOTORS are giant killers in their own right. In many installations they replace more expensive units many times as bulky. Keeping size and weight to a minimum, they help cut operating costs wherever they are applied.

EASTERN INDUSTRIES, INC.

296 ELM STREET • NEW HAVEN 6, CONN.

● *To see if one of these units might be your "hen that lays the golden eggs", write for Eastern Bulletin E-800 today.*

TO INDICATE aircraft position with no ground-to-air communication

Combat mission . . . or freight flight . . . now we are working to help the pilot locate his position without a radio beacon – merely by equipment right in the cockpit of his plane! Thanks to a Ford Instrument Company design, development and manufacture . . . another step is being taken toward greater flying safety.

This is typical of the problems that Ford has been given by the Armed Forces since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

FORD

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

Aluminum, like no other metal, combines good looks, light weight, high heat and electrical conductivity, corrosion and red-rust-resistant properties. What's more, its excellent machinability spells fast, accurate, low-cost production of intricate shapes by hand screw machine and single and multiple-spindle automatic screw machines. When you consider that three times as many parts can be machined from a pound of aluminum as from a pound of heavy metal, you find its cost less than for most other metals.

For these reasons, needle valves, electrical switch components, gears and camera parts are fabricated from aluminum as well as all types of fastenings—wood screws, machine screws, bolts, cap screws and nuts.

Aluminum permits faster feeds and speeds, but each alloy is a different metal, and machining characteristics of each must be taken into account. Alcoa, with years of experience machining aluminum, has the background necessary to make proper alloy selection for a given product. Too, it takes great care in tool choice, condition and setting—the keys to accuracy and good finish.

Someday, you may ask yourself, "Why aren't we using aluminum screw machine products?" To help you provide the answer, we submit that the following is . . .

What tomorrow's Design Supervisors should know about Aluminum Screw Machine Products and Fasteners today

About Alloy Selection

In choosing an alloy, it is important to select the easiest to machine—that in addition possesses all the necessary physical and mechanical properties your product demands.

Alloy 11S-T3 is the best all-around alloy for machining. It is used in a wide variety of general applications where good machinability is important. Its free-machining elements, bismuth and lead, account for this and also the fact that good finishes can be achieved even at high speeds. In fact, the only limiting factor today to the speed at which 11S-T3 can be turned is the speed of the machine itself.

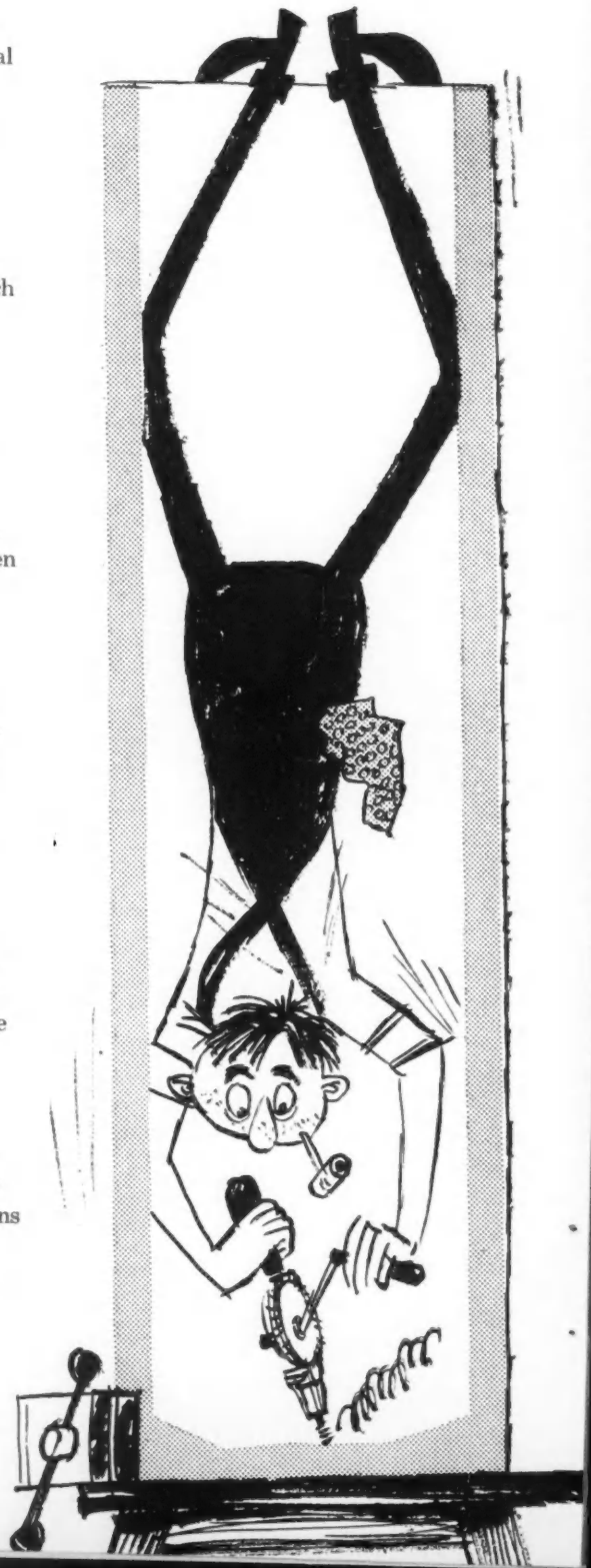
Alloy 11S in the T8 condition is artificially aged 11S-T3, and has greater strength than the latter with similar machining characteristics. It is the better of the two for deep drilling applications where hole depth is greater than four to six diameters.

Of the heat-treatable alloys, 17S-T4, 24S-T4 and 61S-T4, 17S-T4 is most commonly used for its high strength or when deep drilling is called for. Alloy 17S in the T4 condition should be employed for general uses because of its higher mechanical properties and lower material cost.

Alloys 24S-T4 and 61S-T4 are the next most commonly used of the heat-treatable alloys. When product application calls for high resistance to corrosion, where anodic finishes are to be applied or where parts are to be machined from tubing, alloy 61S-T4 is used. Alloy 24S-T4 is now widely accepted as the nut, bolt, screw and washer alloy because it has higher strength. Too, there is an advantage in standardizing on one aluminum alloy for this type of use.

With alloys containing 98.7 and 98.8 per cent aluminum, there is higher electrical conductivity with a slight sacrifice in machinability. Alloy 2S, which is slightly harder than the purer alloys, gives better machinability and is preferred over the purer alloys because of its higher strength. It is especially good when severe forming operations, such as spinning ends closed, flaring, flattening or upsetting, are to follow machining. Its high resistance to corrosion is used to good advantage in fittings for cooking utensils, for applications that require welding, conduit clamps, for gasket and sealing washers where close fit demands good deformation.

"... deep drilling where hole depth is greater than four to six diameters"



About Physical Properties

The aircraft industry was one of the first to recognize the advantages of aluminum in any fabricated form—largely because of its good strength-weight ratio. And that holds true for aluminum screw machine products and fasteners as well. For example, 24S-T with its light weight, 0.100 pound per cubic inch, has a yield strength of 48,000 psi and a tensile strength of 68,000 psi.

There is an advantage in machining battery caps and molded plastics inserts of aluminum. Since the coefficient of expansion of aluminum is similar to that of most plastics, the often severe disadvantage of combining materials with dissimilar rates of expansion and contraction no longer presents a problem.

Although cutting speeds do vary according to the alloys and part size, surface speeds up to 700 sfm are standard for turning round bar stock with a box tool. With square or hex stock, surface speeds of 300 to 450 sfm are common. And recommended feeds are equal to or above those used for most other metals depending on the depth of the cut, the tolerance and surface finish required. Generally, tolerances are quite close, but may be improved by slowing the feed. Surface finishes usually run better than five micro-inches with a box tool.

Who uses Aluminum Screw Machine Products & Fasteners

Who Uses Aluminum Screw Machine Products & Fasteners

Probably more parts of all sizes and shapes are produced by machining than by any other primary fabricating process. True, during the war, most of Alcoa's output of screw machine products went directly into the war effort.

But, today, in addition to supplying defense needs, machined parts are going into a staggering variety of products. Listed here are a few. Is yours among them?

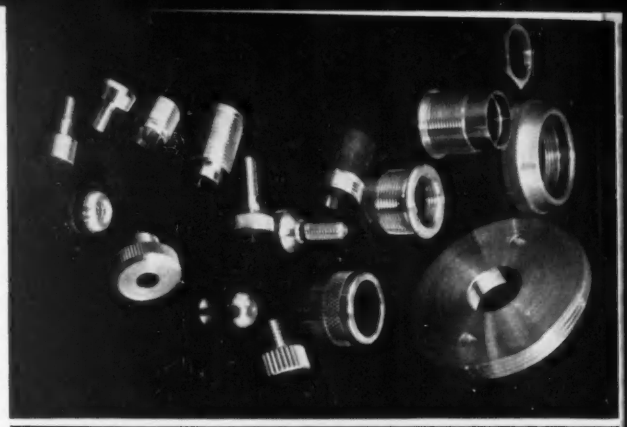
ELECTRICAL SWITCH COMPONENTS—Aluminum's high electrical conductivity makes it a natural for use in electrical switch components. And, with its high resistance to corrosion and chemical attack, it is invaluable when exposed to weather or in use about process industry areas. It is lightweight, clean and bright. Best of all, despite its slightly higher raw-material cost, its end cost is lower since three times the number of electrical components can be turned from a pound of aluminum as from a pound of heavier metal.

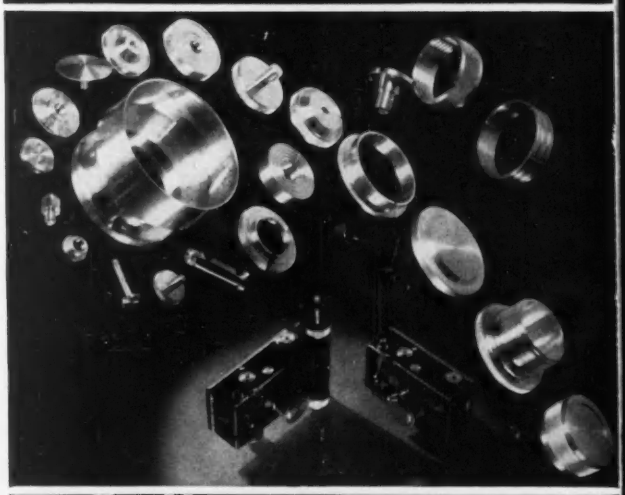
CAMERA PARTS AND ACCESSORIES—Aluminum is rapidly replacing other metals in cameras of all kinds. Its naturally good-looking finish, especially when enhanced by special anodic or chromium finishes, imparts long-lasting good looks and extra "buy appeal" to any product. Machined from 11S and 17S alloys, these camera parts are light, strong and will give years of dependable service.

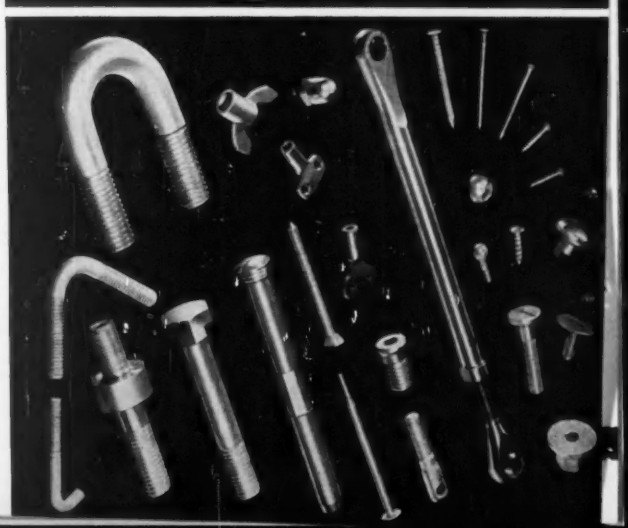
STANDARD FASTENERS—In assembling aluminum parts, it is best to use aluminum fasteners, first, to avoid any galvanic action, and second, to provide a uniform appearance. Thousands of standard fasteners are kept in stock at Alcoa to provide prompt service to your orders. Among these are machine screws, wood screws, sheet-metal screws, bolts, nuts and washers.

SPECIAL FASTENERS—Where product design specifies and quantity justifies fasteners of special design, Alcoa's complete hand and automatic screw machine facilities as well as cold-heading equipment stand ready to produce them to your specification. Such fasteners are available in a wide range of alloys, types, sizes and finishes. Added protection of an Alumilite* finish can be furnished if desired.

*Trade Name of Aluminum Company of America







About Finishes for Aluminum Screw Machine Products and Fasteners

Choose a finish for your product that is in keeping with its function. Ask yourself, "Does it need an especially attractive luster for attention-getting sales appeal, or would it be enough to supply the very minimum finish and rely only on aluminum's inherent lasting qualities?"

Here, finishes for aluminum are broken down into three basic types, mechanical, chemical and electrochemical, and are listed according to increasing cost.

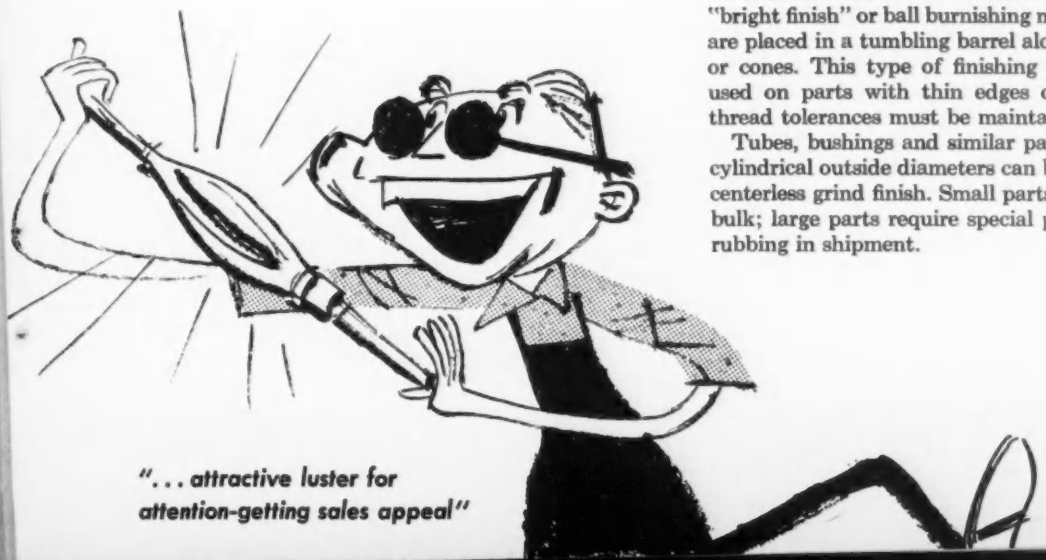
Mechanical

Simplest of all finishes is that which is performed by the tools in shaping or machining the part. Unmachined sections have a natural oxide coating; machined sections take on the finish left by the tool. It should be remembered that the finish in heat-treated parts is characteristically dark.

When appearance is not important, a tumbled finish can be used to remove burrs or sharp edges. Tumbling can be employed prior to threading the piece. But, it should never be specified where threads or close tolerances must be preserved.

Most durable of all mechanical finishes is the "bright finish" or ball burnishing method where parts are placed in a tumbling barrel along with steel balls or cones. This type of finishing process cannot be used on parts with thin edges or where precision thread tolerances must be maintained.

Tubes, bushings and similar parts having straight cylindrical outside diameters can be furnished with a centerless grind finish. Small parts can be shipped in bulk; large parts require special packaging to avoid rubbing in shipment.



"... attractive luster for attention-getting sales appeal"

Scratchbrush, or satin finish, a modification of the scratch-brush method, is most generally used on pots and pans, but may also be used on small screw machine parts used to assemble utensils in order to give uniform texture.

Polishing, an operation which uses a fine-grit emery held in suspension by a tallow, oil or beeswax, gives what is called an "oiled" finish. It is often used just prior to final buffing, but can be used to achieve texture similar to that of the satin finish.

The buffed finish brings out a high luster, with all minor surface scratches or lines removed. Or, a second buffing operation may be used. This, the highest grade finish available for screw machine products, is performed only after preparatory grinding, oiling and first buffing have been performed. Because its extreme high polish will show marks readily, this finishing technique is rarely used unless it is to be followed by an anodizing process.

chemical

Chemical etch is an economical way of imparting a uniform frosted finish to aluminum. Actually, a microscopically rough finish is produced which tends to hide surface scratches and give a light-diffusing texture to the surface.

electro chemical

Alumilite or anodic coatings, when applied to screw machine products, provide finishes which are protective, decorative and functional. Threaded parts have less tendency to bind. And Alumilite offers protection against weather, wear and chemical attack. No matter the texture of the metal on which they're applied, that texture will be reproduced after the anodic coating has formed. Clear, translucent or opaque finishes are possible, but for uniformity between related parts, each should be made of the same alloy and temper.

The Alumilite finish when it is first formed is filled with smaller-than-microscopic pores. When it is important to preserve the appearance of the coating, special sealants fill those pores, making the surface stain resistant. If protection is paramount, corrosion inhibitors such as chromates may be absorbed and sealed within the coating to prepare a base for enameling. Or, dyes can be absorbed into the solution which lend a unique colored finish with all the luster of the metal showing through.

"... fine threads have a tendency to seize"

What you should know about designing for Aluminum Screw Machine Products

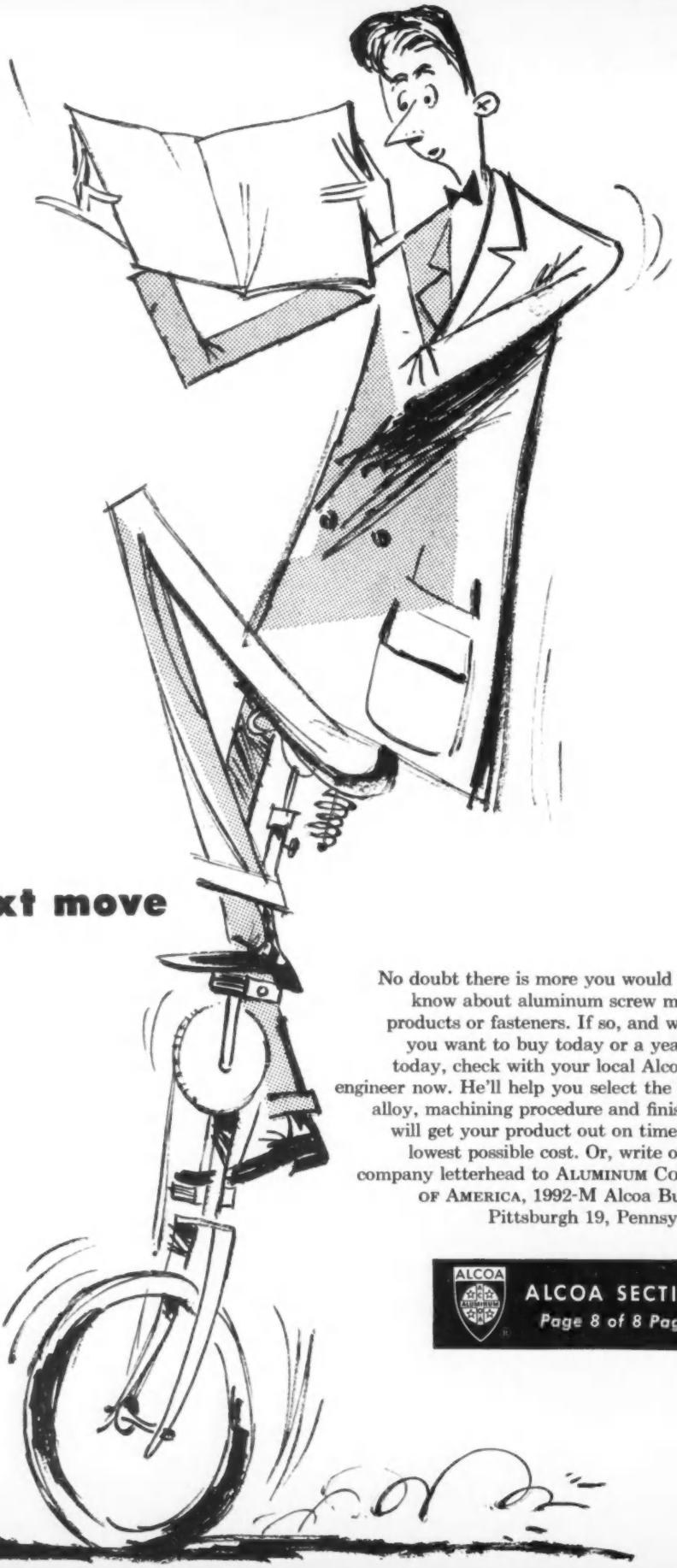
Although most designers are familiar with good automatic machine practice, here are a few points to keep in mind when designing for aluminum screw machine products:

TOLERANCES—Should always be as large as possible with close tolerances specified only on those dimensions critical to the part's function. Costs are directly proportional to tolerance requirements. Location of cross holes, slots, milled sections and trademarks should not be held to close tolerances unless they affect the functioning of the part. If an outside portion of the product need not be machined, that point should be designated, and standard bar stock dimensions should be given.

DRILLING—Whenever possible, specify standard drill sizes. In some cases flatter angles can be used, but absolutely flat-bottomed holes usually mean extra expense. Holes deeper than six times their diameter are difficult and expensive to drill. Wherever possible, diameter should be increased; or, possibly, two holes, each with successively larger diameters, could be drilled.

THREADS—Generally, fine threads or those having a "V" shaped contour should be avoided because of their tendency to seize. And, you should avoid threading close to a shoulder or tapping close to the bottom of a hole. Tool breakage and slower production often result.

BURRING—Where burrs occur, specify the removal of only those that must be removed. In some cases, deburring can cost as much as the machining operation itself. Closely related to the problem of burrs is that of sharp corners. Corners resulting from the intersection of two turned surfaces can often be chamfered at no extra cost. But, at the intersection of a turned and unturned section, chamfering usually requires an extra, costly operation.



Your next move

No doubt there is more you would like to know about aluminum screw machine products or fasteners. If so, and whether you want to buy today or a year from today, check with your local Alcoa sales engineer now. He'll help you select the proper alloy, machining procedure and finish that will get your product out on time at the lowest possible cost. Or, write on your company letterhead to ALUMINUM COMPANY OF AMERICA, 1992-M Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA SECTION
Page 8 of 8 Pages

Alcoa brings the world to your armchair with "SEE IT NOW" featuring Edward R. Murrow, Tuesday evenings on most CBS-TV stations.

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. . . around this Inexpensive Gage Head Cartridge

Measures by .0001" —.00001"

Compact, shock-proof, and moisture-proof, this Brown & Sharpe Gage Head Cartridge No. 953 gives you a simple means for designing high precision into your own gaging fixtures.

Readings in .0001" to .00001" are taken on the No. 950 Electronic Amplifier. Simply plug the cartridge into the amplifier. You take readings directly from the amplifier's accurately graduated dial . . . only one master required for setting. And you can design cartridges into several fixtures and use the same amplifier on all of them.

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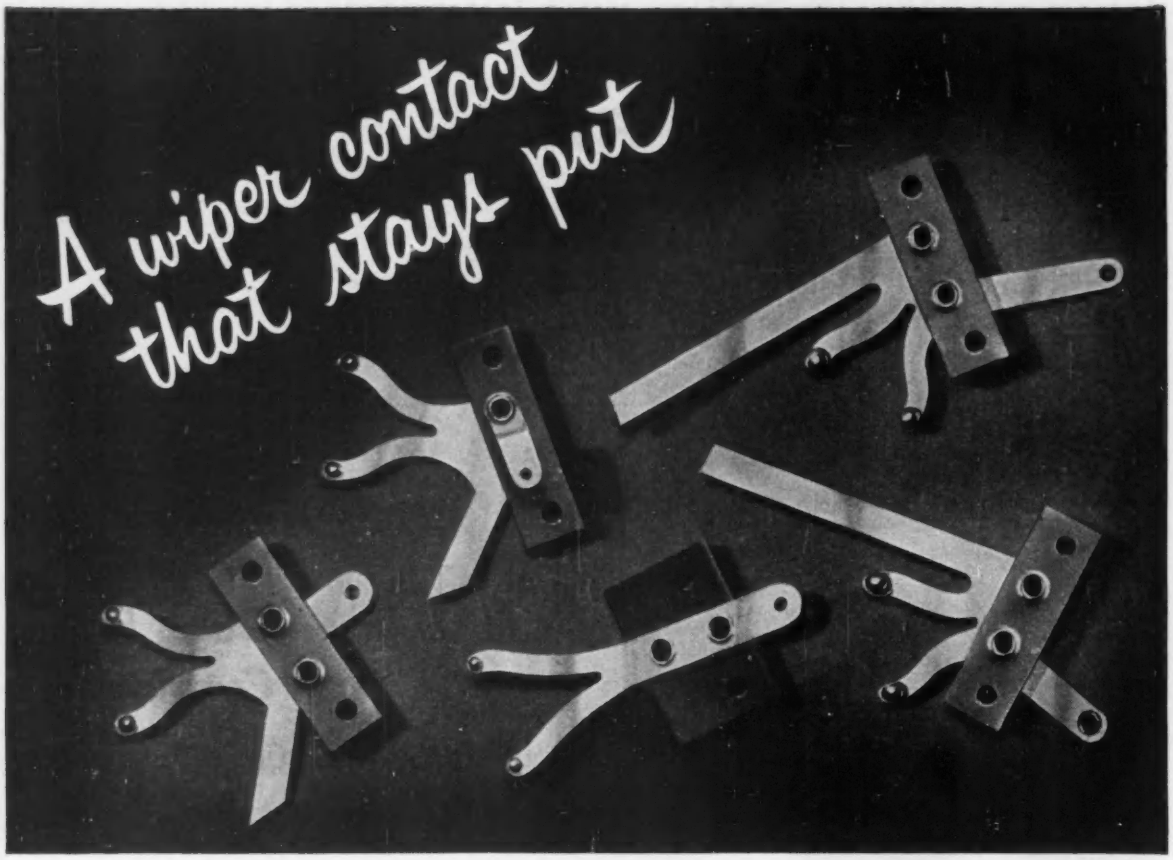

Data supplied by the Radio Condenser Company, Camden, N. J.

IT'S MADE OF BERYLCO BERYLLIUM COPPER

Why beryllium copper is specified more and more for electronic equipment is illustrated by this wiper contact for a variable condenser used in Signal Corps combat transmitting and receiving equipment. It is made of quarter hard Berylco 165 strip, .014" thick, cadmium plated. The contact buttons are silver.

Electrical conductivity here is a must, of course. But even more important is the degree of contact the part makes with the shaft. Too little pressure will make a poor electrical contact; too great a pressure will excessively load the shaft. In production, the wiper is tested with a combination leaf spring gage and electric continuity checker to register between 40 and 70 grams of pressure.

Once this adjustment is made, the Berylco contact will exert a constant pressure, come what may. In fact, it will remain in adjustment even after hand-forming during the checking operation.

It is just this ability of Berylco to solve conflicting mechanical, electrical and service requirements that makes it valuable to designers. Here, in one alloy, are combined such properties as strength, conductivity, corrosion resistance and elasticity—a combination no other alloy gives you.

If you would like to include beryllium copper in your plans for the future, we invite you to share the know-how of the world's largest producer of this unique alloy. For engineering help or sample material, call or write any of the offices listed below.

INVALUABLE

This 16-page booklet, called APPLICATIONS UNLIMITED, contains nearly 40 case histories — shows how Berylco has solved many troublesome design and engineering problems. Send for your free copy today.

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originator and world's largest producer of hardened Self-tapping Screws, and a leading manufacturer of Socket Screws and other fasteners, is now a Division of General American Transportation Corporation

GENERAL AMERICAN, with principal offices in Chicago, owns and operates the nation's largest private fleet of freight cars which are leased to many of the foremost industrial companies, and to railroads. In addition, it is a major builder of all types of freight cars, owns and operates tank storage facilities, and is engaged in the manufacture of process equipment and molded plastics.

In pursuance of a program of diversification, General American has acquired the business and assets of the Parker-Kalon Corporation through the purchase of capital stock. The business will henceforth be operated as the Parker-Kalon Division of General American Transportation Corporation.

The present management of Parker-Kalon will continue in charge. The sales and service policies which have won the approval of the many thousands of P-K customers will remain in effect. As always, P-K Fasteners will be sold through P-K Distributors in every industrial area in the United States, Canada and in many foreign countries.

With the far greater resources available through its new ownership, Parker-Kalon will accelerate a program of improvement and expansion. New production and warehouse facilities will be built to meet the constantly increasing demands for P-K fasteners. Engineering and research will be augmented to speed the perfection of new P-K products now in development.

Now, even more than before, you can rely on Parker-Kalon for leadership in fastener design, for consistently high fastener quality, and service in step with your needs.

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Division

General American Transportation Corporation
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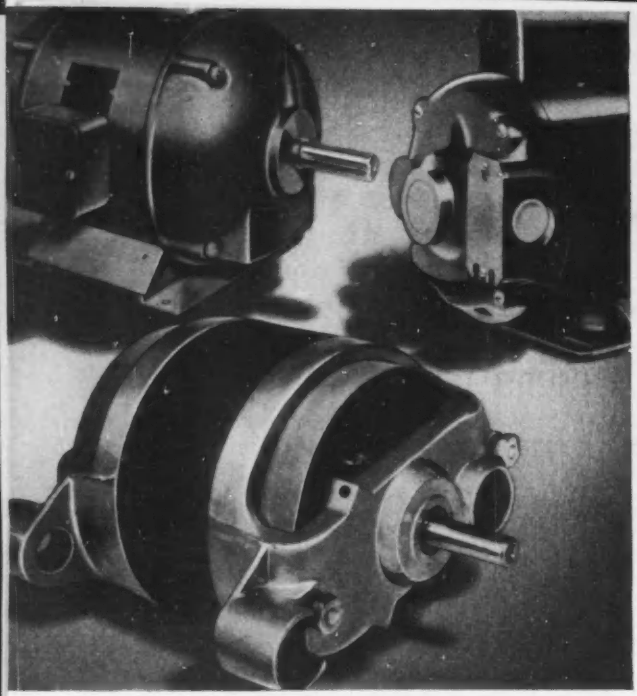
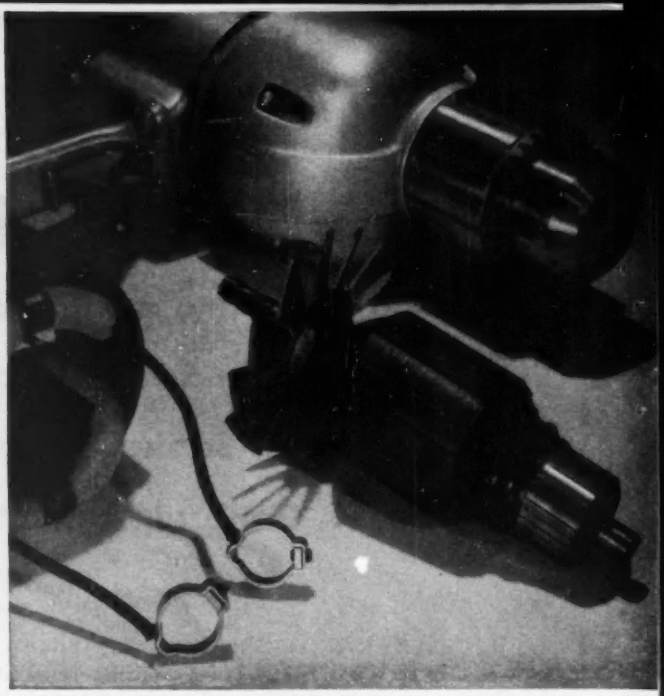
GENERAL AMERICAN





Complete Motors ... or Motor Parts

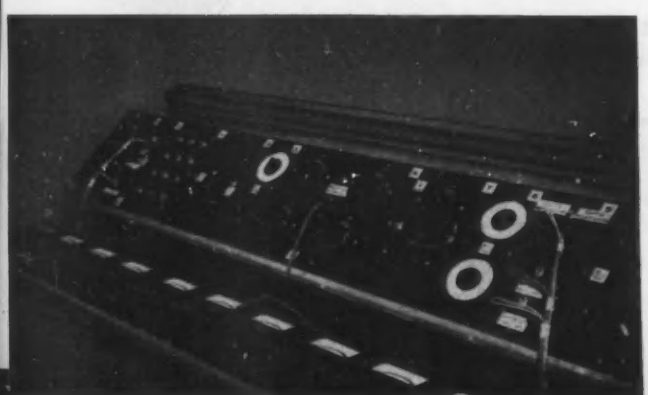
Let your design problem make the choice!

Standard motors and matched motor parts represent only the beginning of what R & M is qualified to build! Special R & M fractional-horsepower with *any* housing design—or specially designed motor parts to fit your housings—are regular R & M contributions to products such as those listed at right:

Portable Saws	Vacuum Cleaners	Portable Grinders
Drills	Files	Sirens
Nut Setters	Sanders	Hair Driers
Hammers	Pumps	Advertising Devices
Routers	Compressors	Ventilating Equipment
Screw Drivers	Hones	Oil Burners
Hedge Trimmers	Business Machines	Surgical Instruments
Lawn Mowers	Cast Cutters	Grease Guns
Nibblers	Food Mixers	Vibrators
Lock Mortisers	Polishers	Die Sinkers
Valve Grinders	Planers	Waxers

The machine that tests motor performance . . . in minutes instead of months!

Formerly it took months to do a really thorough job of calculating motor performance and requirements for a given job. Now, using the unique R & M "Electrical Slide Rule," the performance of any one motor design can be calculated in about 20 minutes! Result? R & M can engineer a motor to your exact requirements . . . thoroughly, accurately, *and in time to meet your production and marketing schedules!*



You can expect quality . . . from every Robbins & Myers motor!

Here, for example, are some of the quality features built into R & M universal motor parts:

1. Every field coil has paper in the slots—in addition to standard taping. More insulation means longer motor life, fewer failures.
2. Insulating material is selected for the job. For example, glass insulated wires are used in sander and saw motors.
3. R & M motors are varnish-dipped and baked—as much as *three times* when service requires it.
4. Standardized commutators and laminations—for mass-production at no sacrifice in quality.
5. Diamond-turned commutators . . . for greater concentricity and smoother surface finish. Brushes last longer!
6. Matched Motor Parts are precision-built, 100%-tested, dynamically balanced, fully interchangeable.

How to select the best Fractional Horsepower Motors FOR MACHINES, POWER TOOLS, APPLIANCES

The most important single factor in motor performance is *selection* of the right motor for the job. That's why R & M offers such a wide variety of types and sizes of motors and motor parts. From these many standard and special-standard types we can, in most cases, help you select the motor to help give your product the best all-around performance.

We Also Custom-Design, Economically!

Your problem may require a custom-designed motor. If so, we'd much rather work out a special motor for you than see you take an "off-the-shelf" compromise.

Ordinarily the extensive calculations required make custom-designing pretty expensive. We've licked that problem, too, with the unique R & M "Electrical Slide Rule." This is an electrical motor-performance calculator. With it, the designer can reduce the work of a whole day or two to about twenty minutes! Naturally you and we both benefit.

Some Other Advantages of R&M Motors

R & M offers some special construction features: extra insulation; glass insulation where heat requires it; diamond-turned commutators; extra varnish treatment; a gratifyingly low failure rate.

As a pioneer in the small motor field, we have designed and built millions of small motors for thousands of different applications. And so we naturally feel well qualified, with engineering skill and experience, and extensive manufacturing facilities, to do an exceptionally good job for you. At least, it won't cost you anything to find out.

Let Us Tell You More

Call the nearest branch office for an R & M Motor Specialist—or write us for the information in which you are interested. Use the check list below.

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Please send me, without obligation, information on:

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- ☐ Capacitor Motors
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Fractional horsepower motors and parts . . . from 1/200 h.p.

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Integral Horsepower motors; famous R&M "All-Weather"* motor with sealed bearings. Up to 125 h.p.

*"*All-Weather*" *is an R&M trademark*

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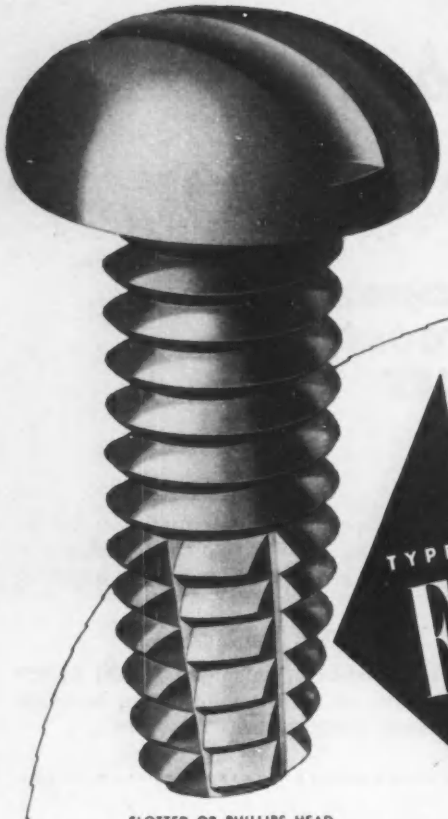

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Originated by P-K, first choice today for fastenings to sheet metal, structural steel, non-ferrous castings and forgings, plastics, plywood, hard compositions. Here's why:

FASTER. No tapping. Simpler, faster than machine screws, riveting, or bolting. Cuts a standard machine screw thread as it's turned in.

STRONGER. No loose fits, mistapping, or cross-threading. Lasting tightness under vibration proved in millions of applications.

LOWER COST. Saves tapping time and tool expense, permits use of power drivers for faster assembly.

IF IT'S P-K . . . IT'S O.K. For guaranteed quality, get the Original, — specify P-K. Samples and application information free. Ask your P-K Distributor or write: Parker-Kalon Division, General American Transportation Corporation, 200 Varick St., New York 14.

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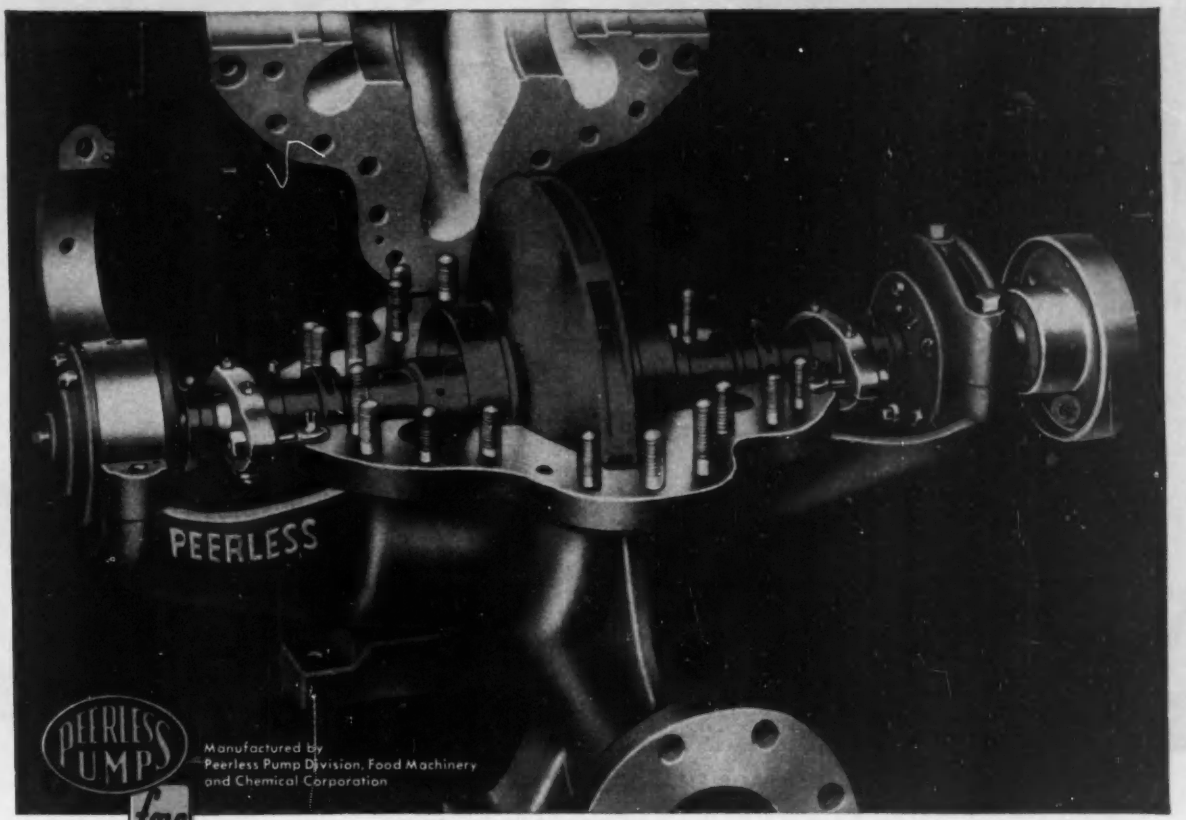

When fire strikes IT PUMPS PROTECTION

This is the heart of reliable systems that protect against hazards of fire

America's annual loss to the ravages of fire is a staggering amount. Reliable plant and property protection often begins with an independent fire protection system, the heart of which is an approved and reliable fire pump. In the manufacture of fire pumps, rigid construction requirements and operational dependability are paramount. This is why National Bearing Division was selected to supply bronze impellers, wearing rings, and shaft sleeves, for this fire pump and other pumps bearing the Peerless name.

In supplying component fire pump parts to Peerless, a supplier must not only meet the rigid requirements of this manufacturer, but also the strict regulations of Underwriters' Laboratories, Inc.; National Board of Fire Underwriters, Chicago; and the Inspection Department, Associated Factory Mutual Fire Insurance Companies, Boston.

National Bearing's proved ability to mass produce exceptionally fine-grained, non-ferrous castings, free from blow holes and sand inclusions, combined with Peerless Pump Division's exacting engineering and manufacturing standards help build fire pumps, and industrial pumps that can be counted to pump a reliable water supply for fire protection or other plant needs.

If your product requires non-ferrous castings or bearings, National Bearing Division has the foundry facilities, experience and skill that will insure better product performance and may possibly lower product costs.

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NATIONAL BEARING DIVISION

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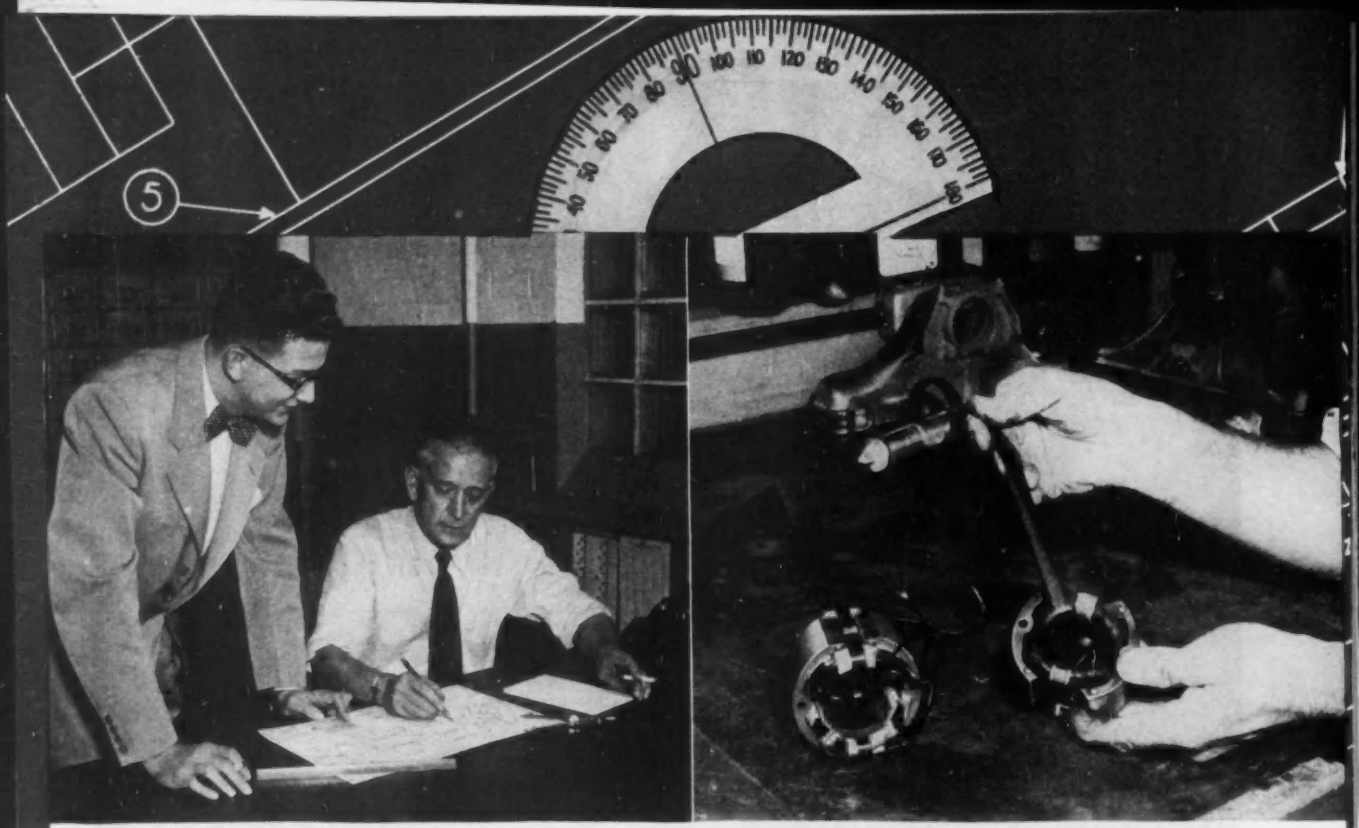
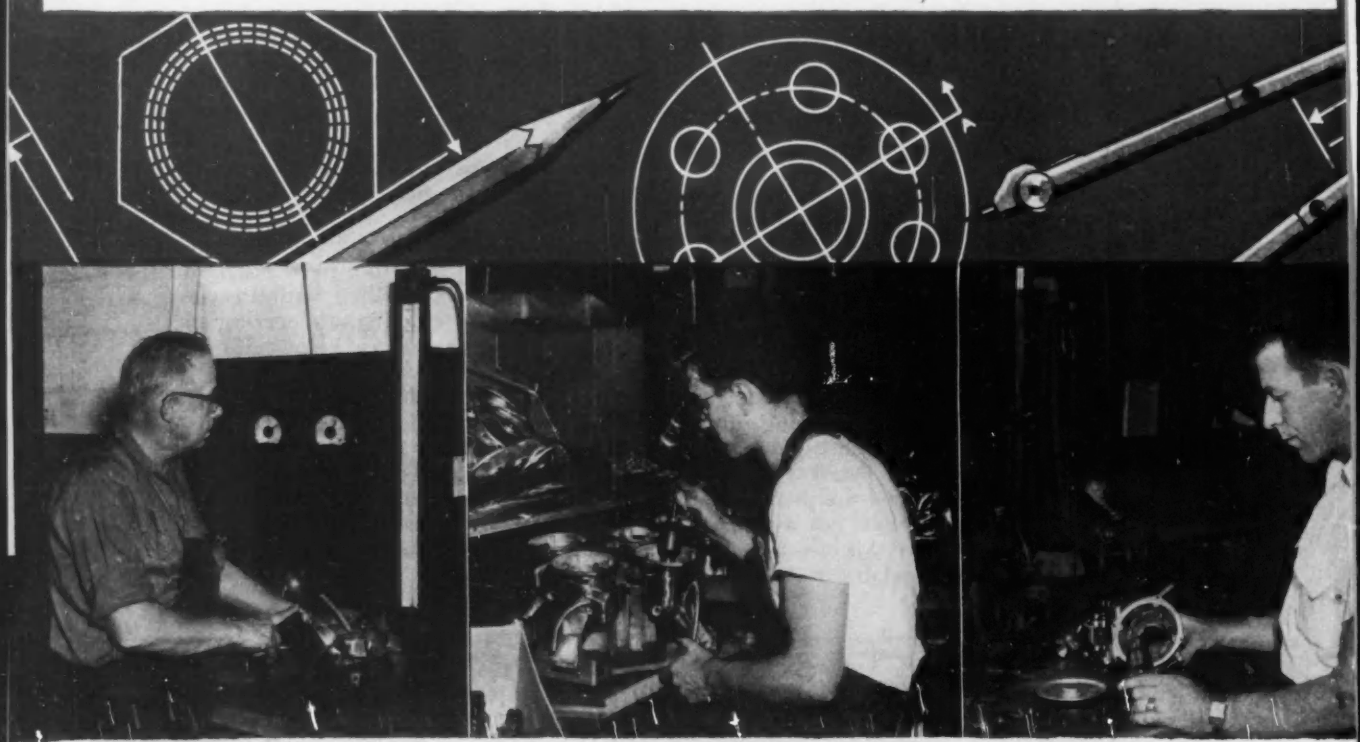


SCOTT AND FETZER PRESENTS PROBLEM to G-E Engineer: how to get a more powerful, yet cooler-operating motor for the Scott and Fetzer Kirby Home Sanitation System in same frame size.

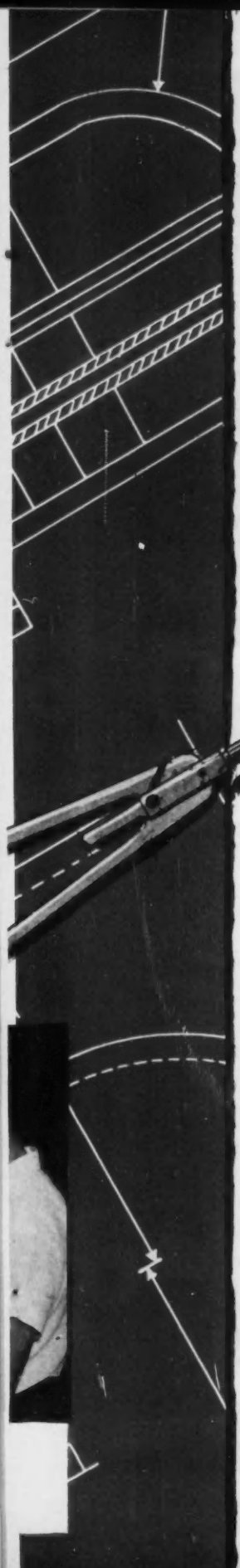
G-E ENGINEERS REDESIGNED the motor windings, and eliminated the tape from the field. This solution was worked out by the G-E Specialty Motor Department in Fort Wayne.



12% MORE POWER was achieved by the Specialty Motor Department's design, yet the temperature rise was cut by almost 50%.

SAME SIZE, SAME COST to customer meant no costly redesign of their product, or extra cost for its better motorization.

INTERCHANGEABLE PARTS, in new motor, eliminate any service problem with older units now in the field.



Here's proof that

It pays to get motor application help from G.E.

Designing skill unbeaten anywhere is behind the significant Scott and Fetzer story told briefly on the left. It typifies the practical advantages you gain when you take advantage of General Electric's motor application service.

Scott and Fetzer, to get the power they needed, were faced with redesigning their product to accommodate a larger, more powerful motor. They took their motor application problem to G.E. The Specialty Motor Department at Fort Wayne gave them the power they needed in a motor of exactly the same size which didn't cost them a cent more!

G.E.'s engineering experience, skill, and thoroughness, which helped Scott and Fetzer, is ready to help you. G.E. Engineers, backed by years of experience in solving motor problems of every kind, will work with you to design the motor which exactly fits your special needs.

Next time you have a motor designing problem, take it to your nearby General Electric Apparatus Sales office. General Electric Company, Schenectady 5, N. Y. 7049

You can put your confidence in—

GENERAL ELECTRIC

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FOR JUST
A BEARING
be sure
it is THE
bearing!
"THE BEARING" will probably be a Johnson Sleeve Bearing, designed specifically for the application. There are several important factors involved in the selection of the correct bearing for any job . . . principally service conditions. Operating speed, temperatures, corrosive conditions, load, shock . . . all must be carefully considered. Since Johnson Bronze produces all types of sleeve bearings, uses all types of bearing metals, their engineers will give you unbiased advice and will assist you in designing the correct sleeve bearing for your application. Write, wire or phone for an appointment with a Johnson Bearing Specialist.
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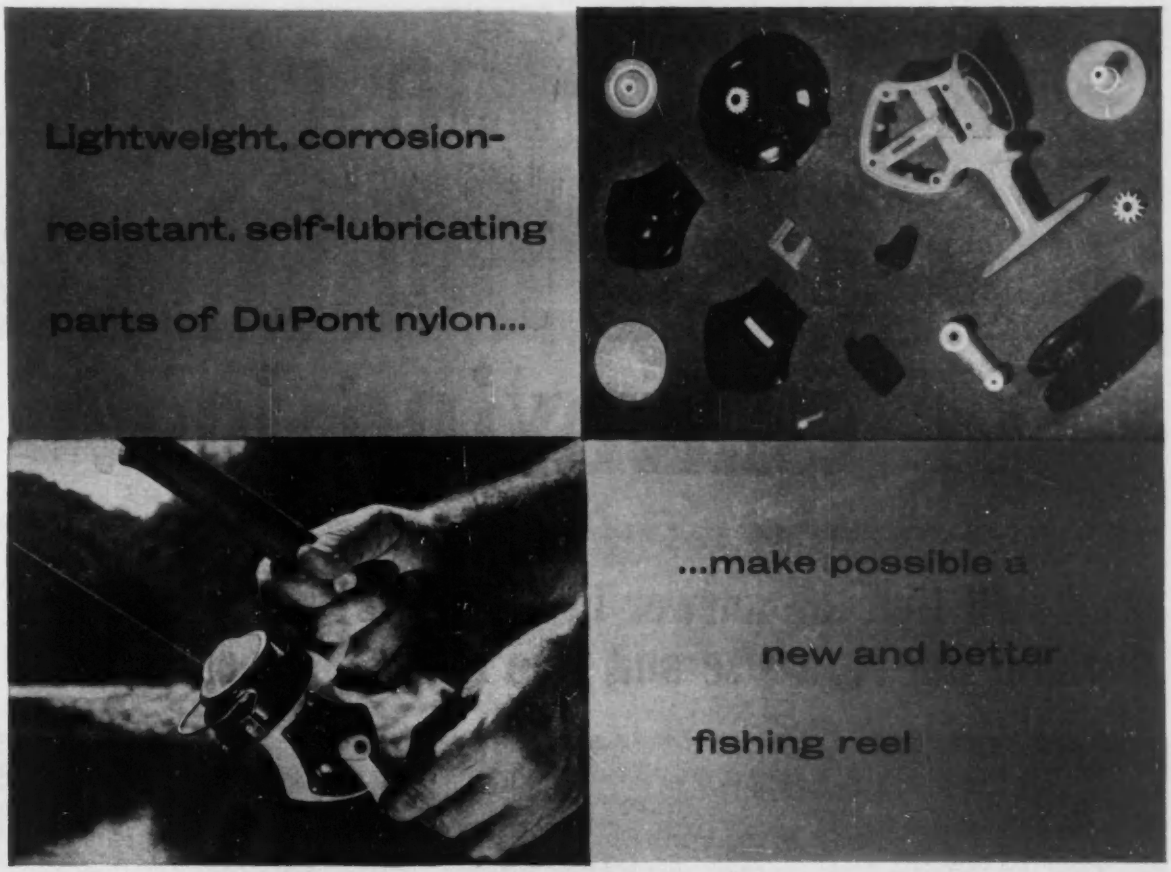

Why not investigate how this unique engineering material-DU PONT NYLON-can help improve your product?

Here is another example of how the unique properties of Du Pont nylon have helped a manufacturer produce an improved product.

In developing a new spinning reel that would give good casting balance with today's featherweight rods, Waltco Products, Inc., sought a lightweight material that would also give long, dependable service.

They found their answer in Du Pont nylon plastic. The final design contains fifteen parts—almost the entire reel—molded of nylon. Since Du Pont nylon is lightweight, the reel weighs less than four ounces, about the same as popular rods. Du Pont nylon is strong and durable, won't chip or crack, and is virtually unbreakable. Its excellent bearing characteristics and wear resistance provide long-lasting, smooth operation of the reel's moving parts without lubrication. And because nylon resists corrosive attack, even by salt water, the reel is self-cleaning. The manufacturer claims that the reel gives near-perfect rod and reel balance plus long life with little or no lubrication.

Perhaps these properties of Du Pont nylon can help your company produce a new or improved product. For further information, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room 1012A Du Pont Bldg., Wilmington 98, Delaware.

DU PONT
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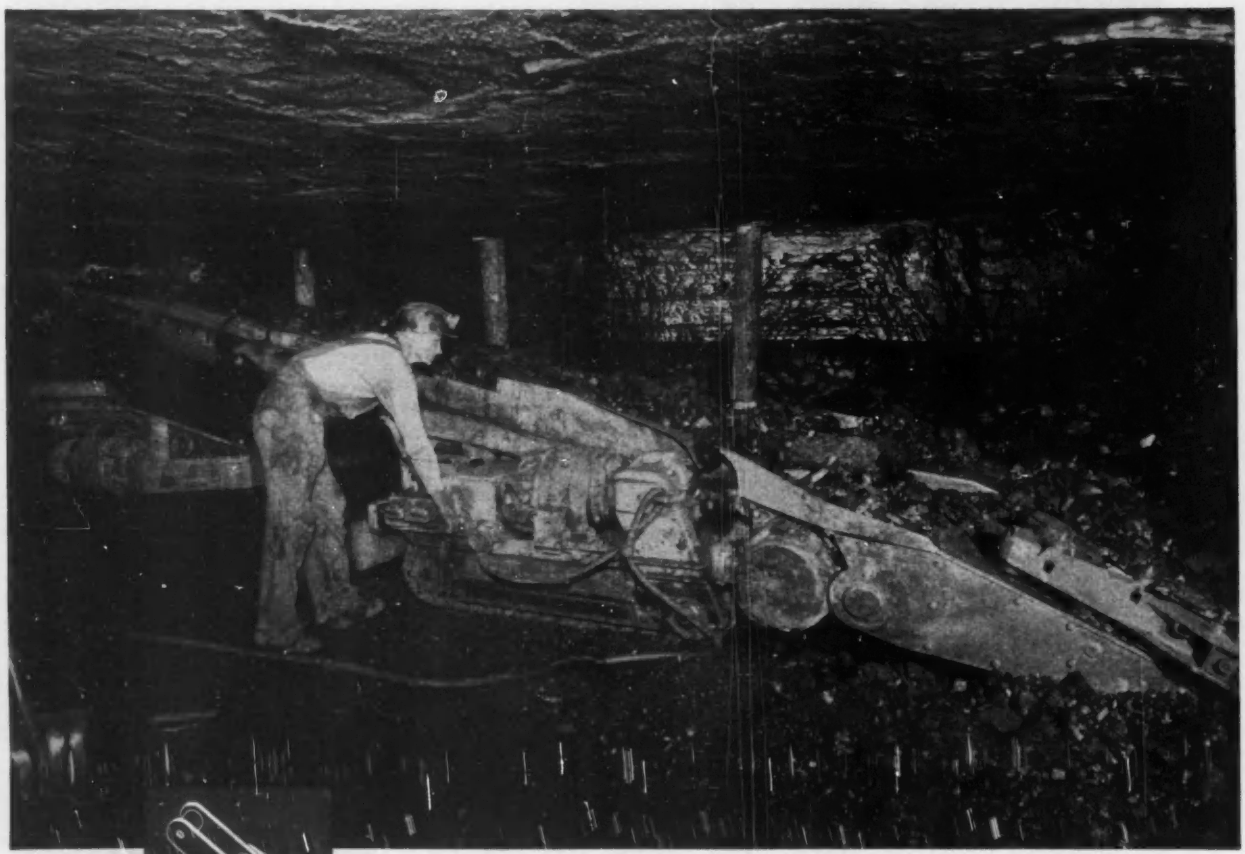
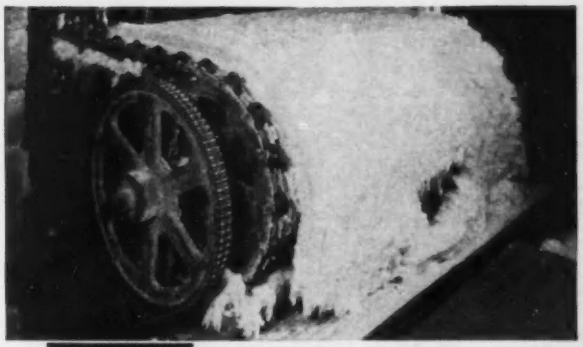
NYLON
Better Things for Better Living
... through Chemistry

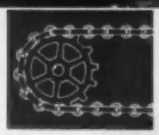
What is the right chain for your drive or conveying job?

You'll find the answer in LINK-BELT's complete chain line... a size and type for your specific job

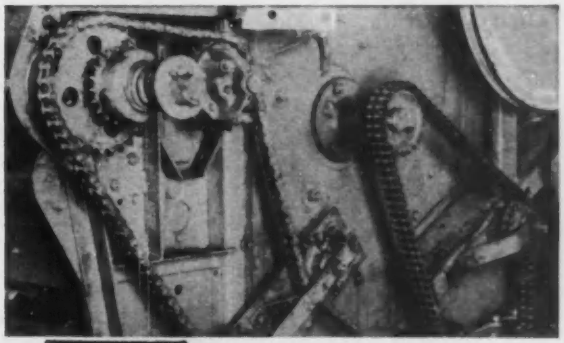


COAL LOADER handles large tonnages underground. To convey the coal Link-Belt Precision Steel Roller Chain, fitted with special attachments, is used. Selected because of its extra strength, it assures long life under the wet, abrasive conditions prevalent in most mining operations.

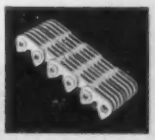




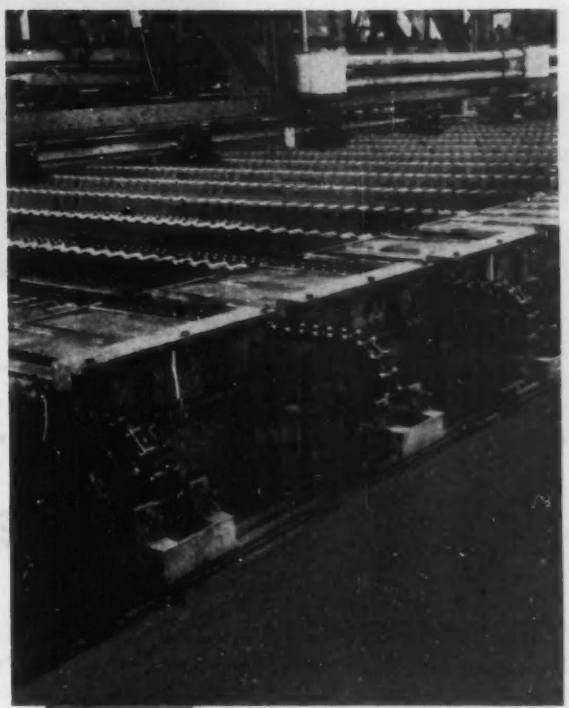
CHEMICAL and allied industries are served by Link-Belt drive and conveyor chains and sprockets. Class SS roller-type chain and Precision Steel Roller Chain appear on this mineral wool conveyor.

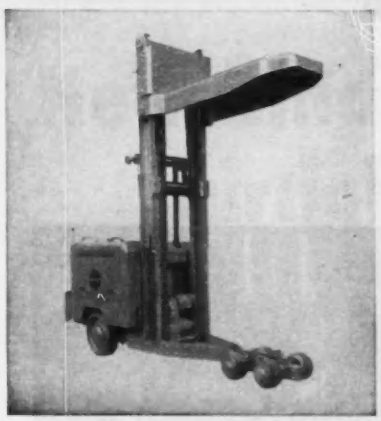


AGRICULTURAL MACHINES use Link-Belt chain for both drive and conveying service. On this combine, single and multiple-width Link-Belt Precision Steel Roller Chain drives were chosen.

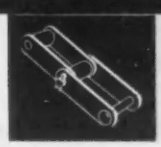


PRINTING PRESS manufacturers utilize Link-Belt Silent Chain drives on the majority of the company's high-speed, high production presses to insure accurate register.





INDUSTRIAL TRUCKS, such as this high-lift model, call for the built-in dependability of Link-Belt Precision Steel Roller Chain.



METAL WORKING plants rely on Link-Belt chain for many tough jobs. Here Class C combination chains with outside rollers feed brass bars into cold-rolling mill.

FOLLOW THE LEAD OF ALL INDUSTRY — FOR YOUR COMPLETE DRIVE AND CONVEYING CHAIN NEEDS RELY ON...

LINK-BELT

CHAINS AND SPROCKETS

15.140

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities.

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fabricate to your design

● There's practically no limit to the design requirements you can meet with Brainard Welded Steel Tubing. You can upset, swage, spin, flange, flatten, taper, or otherwise cold form it. It's an economical structural material—and pound for pound carries more load than any other shape.

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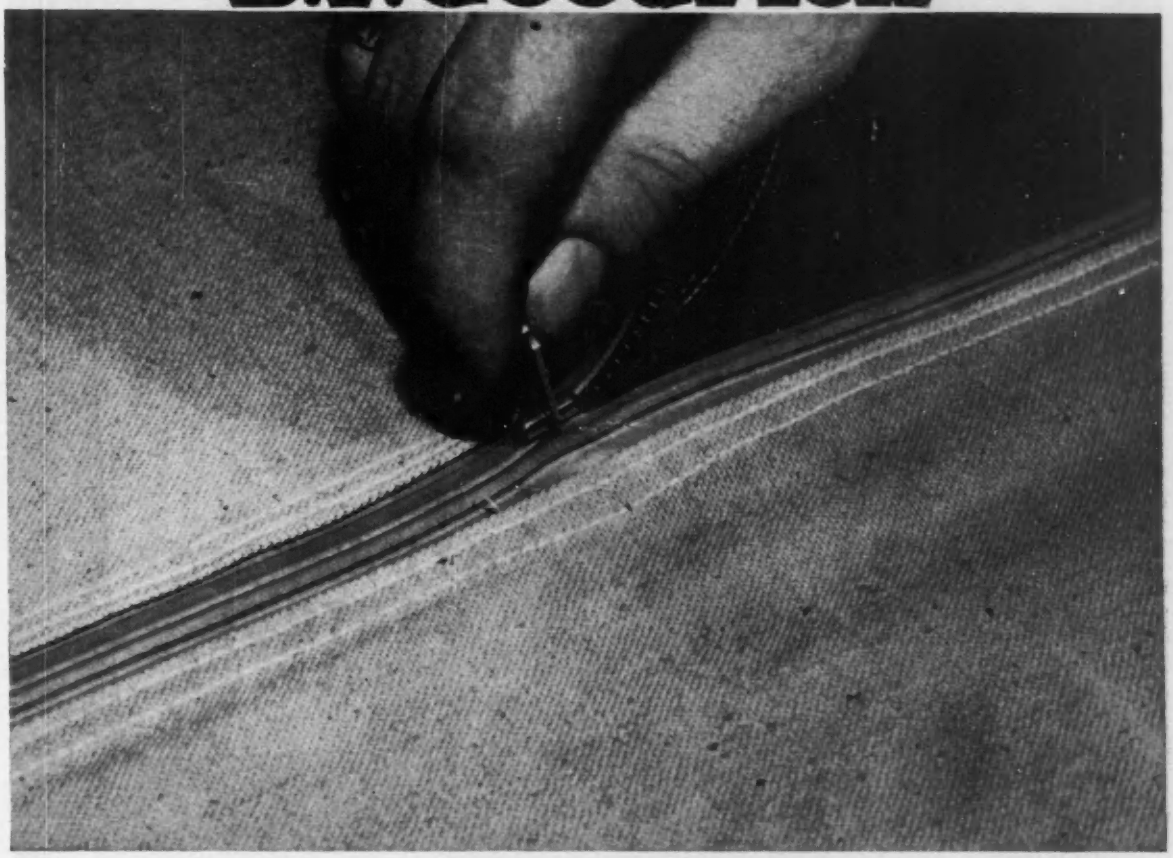

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A NEW KIND OF SEAL keeps gases, liquids, dirt *in* or *out*. Here's how it works:

Rubber lips are molded with hairline precision so that they fit together tightly. They press together even without pressure to seal effectively. And with pressure against the lips, the seal actually tightens. The rubber seal is applied to an ordinary zipper which zips open or shut in a hurry.

The B. F. Goodrich Sealing Zipper is so flexible it goes around curves and odd shapes where clamps won't work. Can be made of compounds to resist weather, oils, gasoline, chemicals. Can be sewn or cemented to fabric, metal, wood, glass. The rubber can be made to match any color. Production costs are often reduced because the zipper is so easy to install.

It has been used in life-saving suits, to seal delicate instruments against moisture, to seal lifeboats against sea water, to seal auto convertible tops against rain. It is ideal for any use that combines a need for an airtight, watertight seal with a need for quick opening.

Write for complete details, sending blueprints or specifications of your products to Dept. A-89, or send coupon below. The B. F. Goodrich Company, Zipper Division, Akron, Ohio.

B.F.Goodrich **Airtight, Watertight Sealing Zipper**

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Gives case histories, design advantages, suggested uses.

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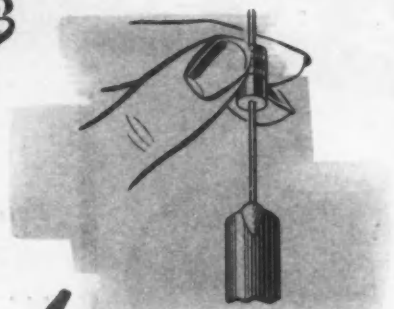
Revolutionary new method wraps connections so tightly that soldering is unnecessary

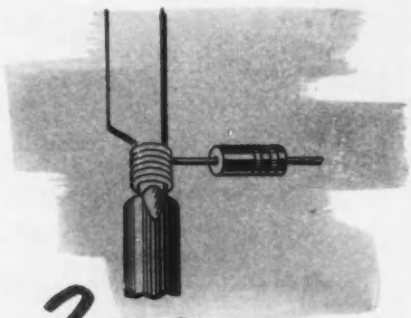
Here is a method that produces electrical connections more reliable than the most skillfully soldered connections . . . in a fraction of the time . . . at a fraction of the cost. Operator training takes only minutes instead of days.

By replacing hand operations with pneumatic or electric Wire-Wrap Tools, you get consistently uniform connections all through the day. Rejects are greatly reduced . . . inspection becomes simple . . . production costs are cut.

Investigate this revolutionary new process—write for Bulletin No. 11, today.



1 INSERT WIRE



2 ZIP... AND

Wire-Wrap Tools

are now available from Keller—the original manufacturer

Iron, Sister!!...

NEW Wire-Wrap Tool

Manufactured under patent license agreement with Western Electric Company Incorporated

3 IT'S FASTENED

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Wire-Wrap Division

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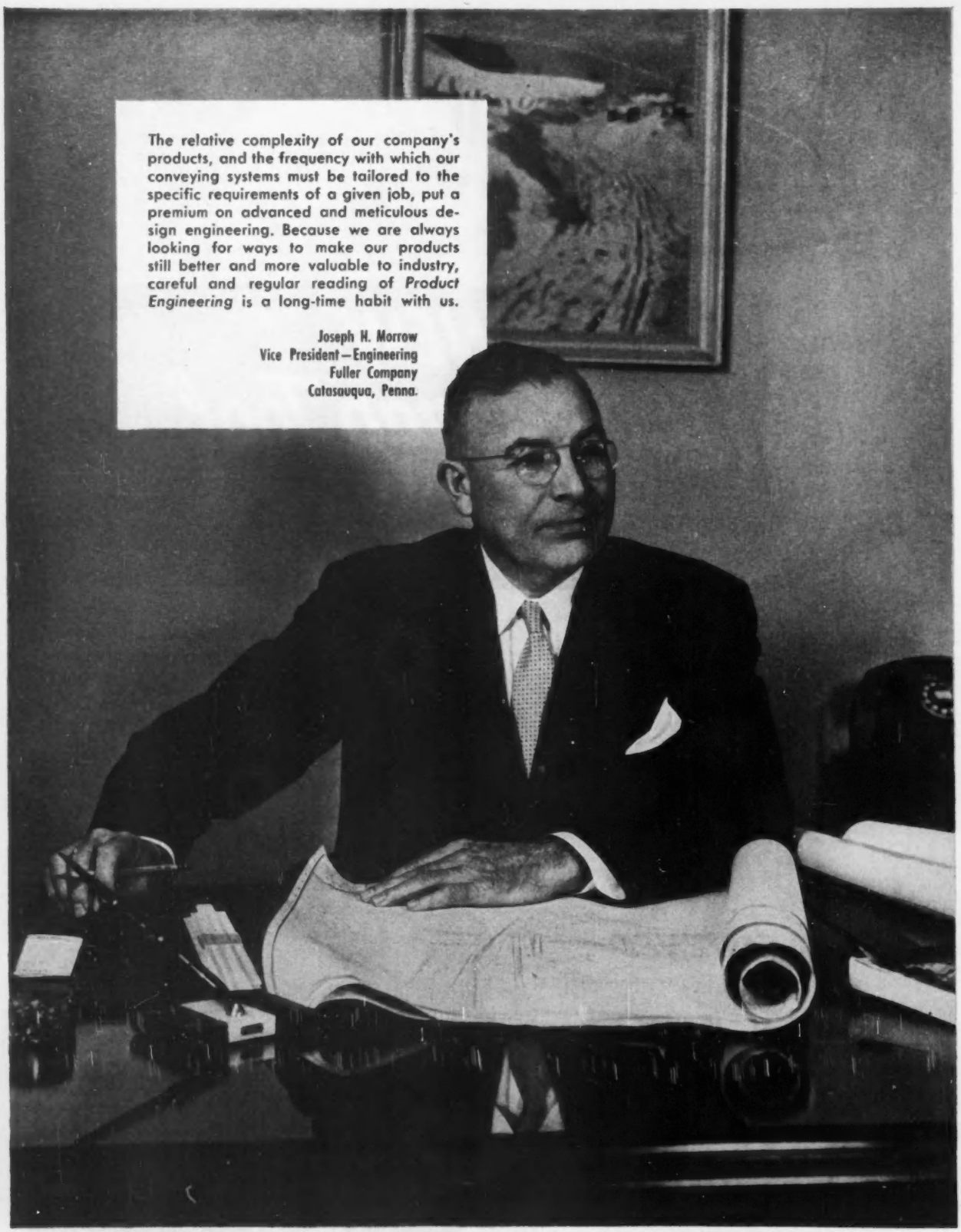

The relative complexity of our company's products, and the frequency with which our conveying systems must be tailored to the specific requirements of a given job, put a premium on advanced and meticulous design engineering. Because we are always looking for ways to make our products still better and more valuable to industry, careful and regular reading of *Product Engineering* is a long-time habit with us.

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Vice President—Engineering
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In selecting an advertising medium to sell any industrial market, it is natural to want the best: the best gives you more for every dollar you invest. And in the product-design field, the evidence clearly shows that *Product Engineering* is more than ever No 1.

Its *all-paid* circulation is now past 25,000, as more and more design engineers turn to this magazine for the wide-ranging job help they can find nowhere else. At least, this seems a sensible answer to *Product Engineering's* steadily growing paid circulation in a field where all other publications are available at no cost.

What's more, the exclusive editorial services which make *Product Engineering* so *wanted* a magazine . . . and therefore one that is so certain to be read intently . . . are constantly on the increase. You can find a good example of this in our Annual HANDBOOK of Product Design for 1954 issue that is just now reaching our subscribers from coast to coast.

Ask your *Product Engineering* representative to show you a copy of the 1954 HANDBOOK. Then go over with him what the end result of *Product Engineering's* great editorial usefulness to its readers means to *you* in superior advertising values. He has a wealth of evidence to show you, and it all adds up to this:

If you want the most in advertising values next year, put the power and impact of *Product Engineering* behind your products. Long before the year is over, you will be very glad you did.

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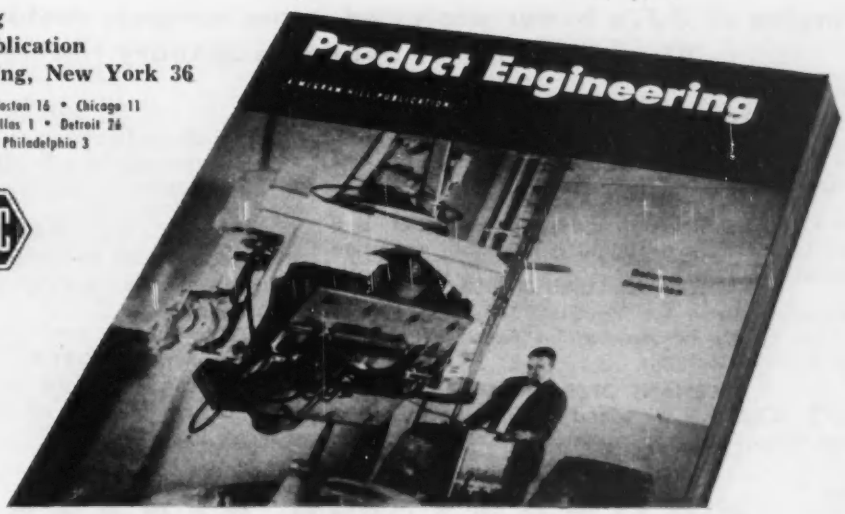
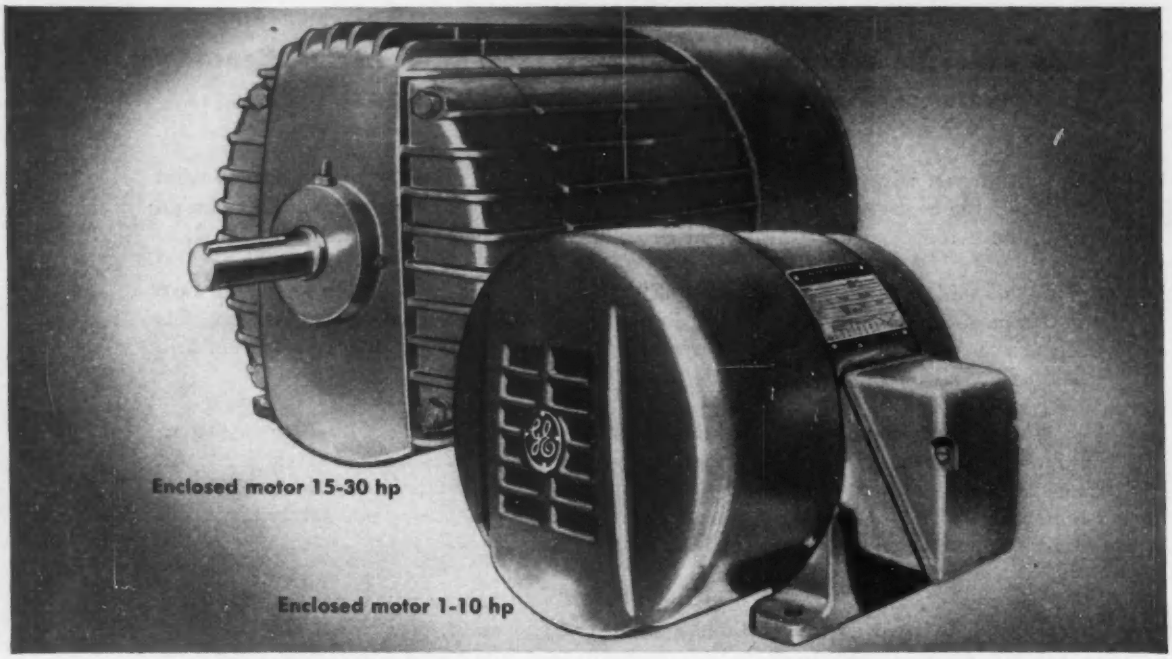


AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

Designer's



ENCLOSED TRI/CLAD '55' MOTORS offer better protection from moisture, dirt, corrosion.

Modernize your machinery

Samples of G.E.'s better-protected, more compact motors available now: 182 and 184 frames available January 1 in quantity.

Now you can specify General Electric's new Tri/Clad '55' motor. It's designed to better all previous standards of motor performance. Here are some of the new features:

TOUGHER INSULATION

New polyester film slot and phase insulation is 8 times stronger than ordinary electrical insulation materials.

HIGHER FULL-LOAD SPEEDS

Tests prove that a new Tri/Clad '55' attains greater full-load speed, horsepower for horsepower, than most ordinary motors.

SONANT OPERATION

New Tri/Clad '55' is "sound engineered" to reduce "siren effect," bearing rattle, and wind resistance.

LIGHTER WEIGHT

Elimination of waste space between stator and frame helps make the new Tri/Clad '55' lighter . . . up to 33% weight reduction in some ratings.

SMALLER SIZE

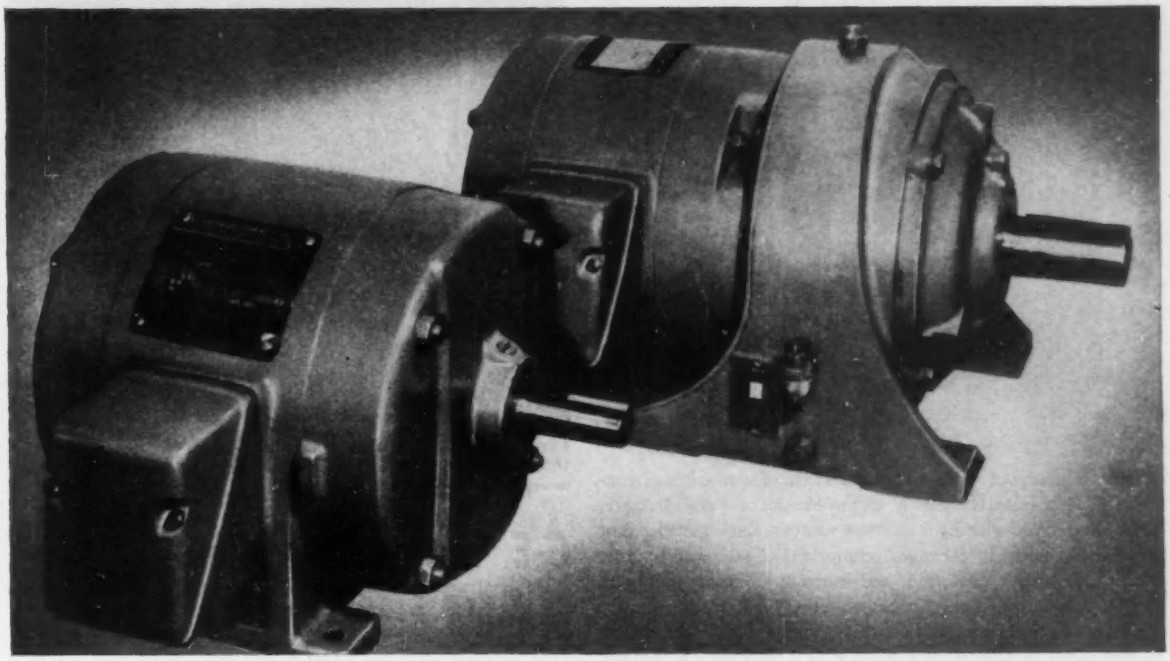
Smaller over-all motor size (up to 40% in some ratings) saves you money on shipping, handling, storing, installing.

To order your new motors, contact your nearest G-E Apparatus Sales Office or authorized motor agent. Or you can send in the coupon at right for three new full-colored bulletins on the complete Tri/Clad '55' motor line.

GENERAL ELECTRIC

Digest

MOTOR & CONTROL HIGHLIGHTS



DRIPPROOF AND GEAR-MOTORS, completely new inside and out, assure longer motor service life.

with new TRI 55 CLAD motors

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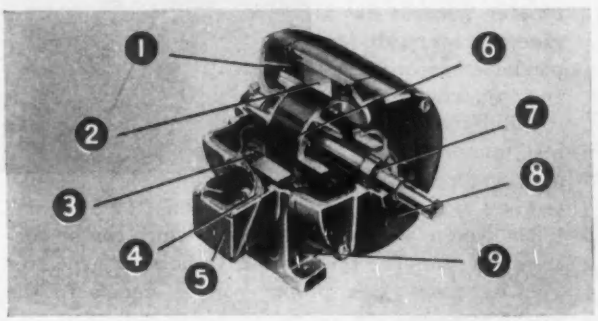

NEW MOTOR DESIGN INCLUDES: (1) polyester film slot, phase insulation; (2) press fitted stator punchings; (3) water-shedding stator windings; (4) perma-numbered leads; (5) easy-access conduit box; (6) solid-cast rotor windings; (7) advanced bearing system; (8) protected end shields; (9) cast-iron construction.

General Electric Company
Apparatus Sales Division, Sec. C668-108
Schenectady 5, N. Y.

Please send me the following bulletins:

√ for reference purposes
× for immediate project

- ☐ GEA-6012 Tri/Clad '55' Enclosed Motors
- ☐ GEA-6013 Tri/Clad '55' Dripproof Motors
- ☐ GEA-6027 Tri/Clad '55' Gear-Motors

CONSULT YOUR SWEETS PRODUCT DESIGN FILE. You'll find "everything electric" for machinery manufacturers in the General Electric section.

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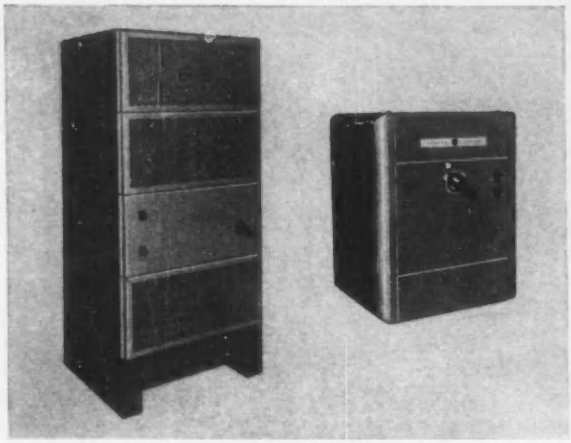
TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS

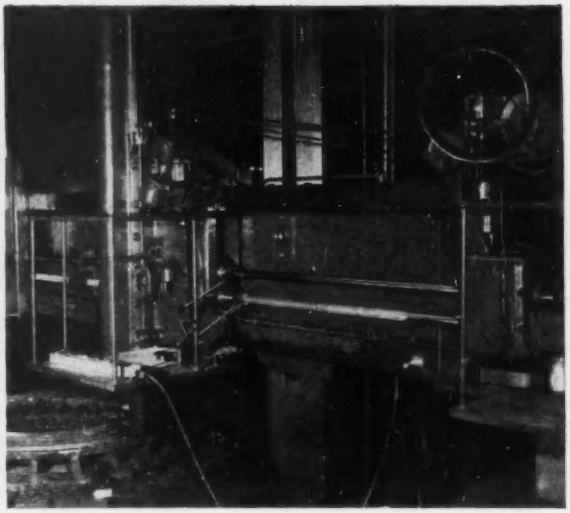
PACKAGED METALLIC RECTIFIER UNITS SATISFY MANY DC MACHINE REQUIREMENTS



Specify a compact G-E metallic rectifier for maximum convenience, low installation cost, and minimum user maintenance, when you consider using d-c power sources. Each rectifier unit is a metal-enclosed "package," comprised of selenium rectifier stacks, insulated transformer and controls. Compact in design, they save valuable space, require no special foundation, offer quick and simple installation. For example, the 25-kw unit shown above on the left is only 25 x 31 x 65⅛ inches. Ratings range from 0.75- to 25-kw (125 and 250 volts d-c) for single units and up to 300-kw for complete installations. Check Bulletin GEA-5658.

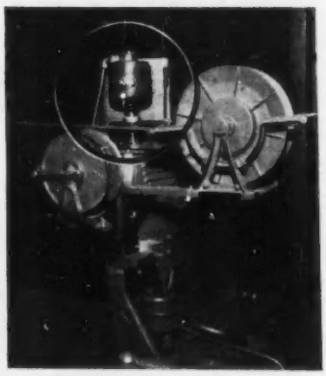
FULL LINE OF PHOTOELECTRIC RELAYS MEETS WIDE APPLICATION, LASTS LONGER

Versatile G-E photoelectric relays are easy to install, adjust, and maintain. They provide an inexpensive and accurate way to count, control, or signal. Sturdy construction gives longer service life, easier installation. Various enclosures for specific applications are available in the line. Relay shown here assures 450 operations per minute. Other models from a complete line of relays, ranging from simple to the highly sensitive units, cover up to 600 operations per minute. For information on the entire line check Bulletins GEA-3533, GEA-5920, and GEA-5921.



PRECISE SPEED CONTROL on this large boring mill is provided by a G-E 1000-rpm, 50-volt tachometer-generator connected to the feed drive—assures optimum milling performance, smooth surface finishes.

G-E tachometer-generator helps provide accurate speed indication



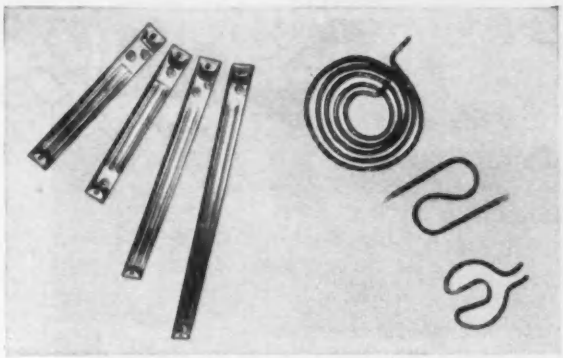
Whether you are looking for a voltage signal or speed indication on a small machine tool or a large machine operation, G-E tachometer-generators give accurate, dependable responses. In conjunction with suitable indicating instruments, they measure rotating speeds from 1 to 15,000 rpm as well as linear speeds which can be converted to rpm. The precise G-E tachometer-generator (shown above) gives proper voltage signals to the control system.

Each tachometer-generator is self-excited, totally enclosed with ball bearing construction. The over-all compactness of the unit assures fast, simple installations. For full information see GEC-1016A.

GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS



EFFICIENT G-E CALROD* HEATERS PROVIDE SAFE, CLEAN SURFACE HEAT

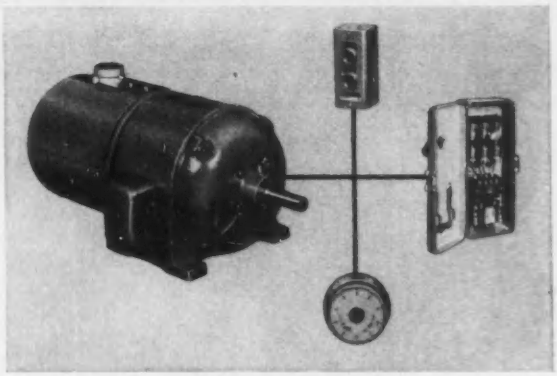
Regardless of the size or shape of your product, G-E calrod heaters wrapped-around, cast-in, or clamped-on, provide convenient, efficient surface heating. For example, the strip heaters at the left are designed for direct clamping to surfaces and the insertion heaters at the right for direct insertion into drilled holes. G-E calrod heaters are available in a wide variety of sizes, shapes, ratings and sheath materials. The Heating Specialist in your nearby G-E Apparatus Sales Office is ready to help you modernize existing design or develop new processes. See Bulletin GEA-5866.

NEW G-E MEASURING CATALOG AIDS LABORATORY AND PRODUCTION TESTING

Available now, this complete and concise 80-page master reference work describes all General Electric testing and measuring devices to meet your laboratory and production testing requirements. Products included range from simple current indicators to complete automatic oscillographs, from roughness scales to the mass spectrometer. Brief descriptions, applications, specifications and prices for each product enable you to make a selection quickly and easily. See Bulletin GEC-1016A.

*Reg. Trade-mark of General Electric Company.

Simple ACA motor gives your machine greater versatility



If you need adjustable speed over a moderate range, the simplest, least expensive way to get it is with the General Electric adjustable speed a-c motor. Available speed ranges are 3 to 1, 6 to 1, or 20 to 1. By a mere twist of the dial you get stepless speed adjustment. This new Tri-Clad* Type ACA motor is G.E.'s answer to your demands for a truly modern adjustable speed induction motor. It operates on a-c without any conversion equipment whatsoever.

There is a G-E adjustable-speed drive to fit your particular job. Smooth pre-set speed control and accurate speed regulation is available from Thy-motrol* drive; precise speed control with Speed Variator. G-E packaged drives are available from 1/40 to 200 hp. For full line of Adjustable Speed Drives, check Bulletin GEA-5334.

General Electric Company, Apparatus Sales Div., Sec. C668-109
Schenectady 5, New York

Please send me the following Bulletins:

√ for reference purposes × for immediate projects

- ☐ GEA-3533 Photoelectric Relay (150 operations per min.)
- ☐ GEA-5334 Adjustable Speed Drives
- ☐ GEA-5658 Metallic Rectifiers
- ☐ GEA-5920 Photoelectric Relay (450 operations per min.)
- ☐ GEA-5866 Electric Heat
- ☐ GEA-5921 Photoelectric Relay (600 operations per min.)
- ☐ GEC-1016A Measuring Equipment and Tachometer-Generator

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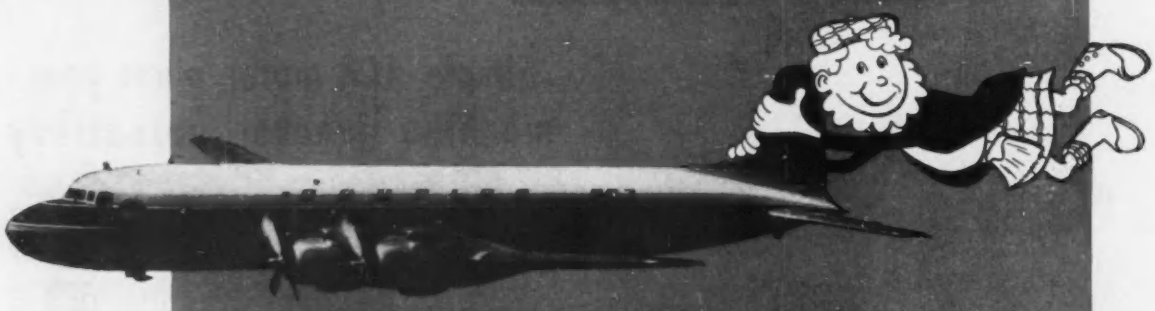

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Perspectives ~ DESIGN AND DEVELOPMENT

METALLURGICAL TREASURE HUNT

Lured by continental Europe's traditional brilliance in research, U. S. executives — particularly those in metallurgical fields — are swarming abroad to visit the laboratories of England, France and Germany. Their object: to uncover production processes, new products or new materials that will improve their competitive position back home. But most are returning empty-handed; a few are bringing back pre-World War II developments.

Since the end of the fighting, conditions in Europe have not been conducive to basic research. Each nation has had its own particular problems that have demanded solution first.

GERMAN REBUILDING

In Germany, every scientist and engineer that remains — the Russians grabbed off many, and the U. S. invited others to work on special defense projects — has concentrated on rebuilding German industry which lost both facilities and markets in the war. The amazing job they have done is indicated by the fact that conquered, bomb-blasted Germany has already surpassed victorious France and Great Britain in economic stability and is capturing export markets with increasing regularity. Example: semi-light metal goods production up 50 percent over last year.

However, German companies are still in the rebuilding stage. Some have barely scraped away all the rubble. New developments in metallurgy, if there are any, are in the blueprint stage; scientists and engineers won't talk about them to visitors.

OLD NOT NEW DEVELOPMENTS

Several widely discussed, supposedly brand new, ideas have been imported. For example, the Croning or shell molding process (Product Engineering, October 1952, p. 121.) has won wide approval from U. S. foundries. Yet Croning made his basic discoveries back in 1939; German foundries used the C-process extensively during the war.

Another borrowed technique is the Junghans process for the continuous casting of alloy steel — producing steel slabs about 38 ft long with cross section dimensions 8 x 14 inches. But this, too, is not a new development.

FRENCH INSTABILITY

Across the Rhine, French scientists have been stymied by an economic situation that threatens to reduce France to the status of a fourth-rate nation. Because of spiraling inflation, unstable government and economic pressures resulting from the Indo-China impasse, there has been little money for fundamental studies. What scientific progress there has been, has aimed at making better use of France's considerable natural resources. Improving steel producing processes is a top priority project.

(Continued on page 125)

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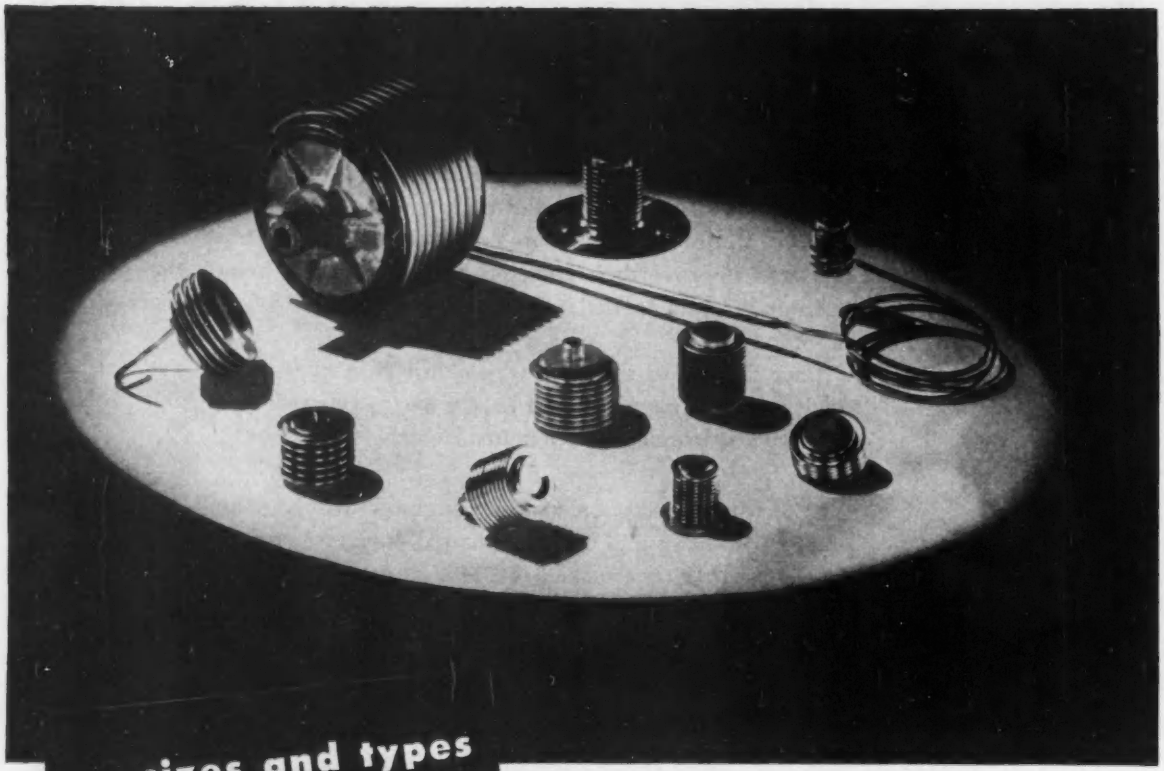

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CONVERTER STEEL

French steelmakers are pioneering the use of converters to produce high grade steels. Usually converter steels are of inferior quality, but the French report considerable success in turning out high quality materials by modifying the refining techniques for the mineral content of the pig iron used. Other improvements have been effective in reducing phosphorous, sulfur and oxygen content of the pigs.

PERRIN PROCESS

For instance, to control phosphorous content, three different techniques are now used: (1) the basic converter process, when phosphorous content is large enough; (2) an improved acid Bessemer process (67 percent of French steel is made this way), when phosphorous content is low; and (3) the Perrin process with a dephosphorizing slag for in-between batches.

The last method, invented over twenty years ago but just being widely adopted, also is effective for the deoxidation and removal of sulfur in converter steels. It produces clean metal, free of inclusions. One other use of the Perrin process: to convert Thomas steel into steel of high purity for the production of high carbon and low alloy, high strength steels.

BRITISH EMPHASIS

In Great Britain, industry and government have poured their limited resources into research rather than production. The results are most apparent in jet engine and aviation fields, where English designs rank with the best in the world. However, the English have been loathe to share some of these developments with U. S. companies, even on a licensing basis.

Actually, British reluctance is an effort to pressure the U. S. into trading American atomic energy data. Ever since British scientists Klaus Fuchs and Allan May defected and turned atom secrets over to the Russians, Washington has embargoed all such information headed for the British Isles, an act the British have resented bitterly. They've reciprocated by being close-mouthed about their best metallurgical developments.

NIMONICS

Of those not considered secret, British metallurgists rate the development of the Nimonic series of alloys among their most valuable assets. Nimonic 75 was the first — developed for turbine rotor blades; 80 and 80A are essentially forging alloys with high resistance to fatigue; 90 and 95 include the addition of cobalt for improved high temperature properties. Still others have been developed for very special applications.

Another project under study is the cladding of the Nimonic alloys to improve heat conductivity. Early experiments have indicated that copper clad Nimonic 75 dissipates heat much better than any other material previously used in jet engine combustion chambers.

CORRONEL B

To improve corrosion resistance, particularly to hydrochloric, phosphoric and sulfuric acids, English researchers have been experimenting with the addition of molybdenum to nickel-iron alloys. One such alloy, "Corronel B," is now available commercially. In the chemical industry, manufacturers of process equipment are using improved types of stainless steel to improve mechanical properties as well as corrosion resistance. Aluminum is also being used, especially in contact with nitric and acetic acid.

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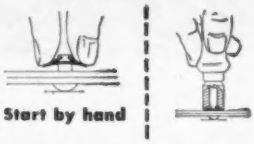

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Expensive Fancies

THERE IS AN OLD STORY about "the two Irishmen, Pat and Mike". It appears that Pat loaded and carted off two wheelbarrows of dirt to Mike's one. When the boss "bawled out" Mike about this deplorable situation, Mike squinted at Pat, scratched his head and remarked, "You're sure right, boss, Pat does beat me about two to one, but then you notice he is not as fancy about it as I am."

There are an endless number of Pat-and-Mike situations in every field of human endeavor. Many people get a great thrill over "being fancy" and get little satisfaction over the quantity of their production. There are those who insist that every blade of grass must be in exactly the right spot and position. And then there is the mechanic who insists that every finished surface must gleam like nickel plating, which he accomplishes by the long tedious application of oiled emery cloth.

There are places for such meticulously fancy men in this world's work. But they and their philosophy are entirely out of place in American mass production operations. Yet an assumption that the American mass production system does not tolerate such time consuming fancifulness in any department of its operations, is entirely erroneous.

Ironically, the greatest exhibition of fancy production in American industry is found in the drafting rooms of engineering departments. Here we see gear teeth drawn to exact scale and profile, knurling shown in meticulous detail, rivet heads drawn in with almost three dimensional effect and fillets made with the greatest of care and time consumption with a bow compass.

Not only do we have "fancy production" in the drafting rooms of American industry, but we even have strong proponents of such meticulous drafting techniques. They claim that it is necessary. The care and accuracy put into a design drawing reflects the quality of the engineering calculations. A free hand drawing issued to the shop tends to make the mechanics careless. The efficiency and accuracy of the work of an engineering department is reflected in the appearance and artistry of the drawings it produces. So claim the proponents of beautiful, artistic, meticulously detailed engineering drawings.

Over the past few years there has been some definite progress made toward the elimination of unnecessary time consuming practices in the production of engineering drawings. Perhaps the most notable accomplishments in this direction are reflected in the General Electric handbook on Simplified Drafting Procedure and the book "Simplified Drafting" by Healy and Rau. Both these books tersely illustrate the great savings in time and money that result when engineering drawings are reduced to their essentials and their quality is measured solely by their accuracy and clarity. Indeed, that should be the only yardstick by which to measure worthwhile engineering drawings.

It can be expected that many engineers will strongly resist the adoption of simplified drafting procedures. That is to be expected. Human beings have a wonderful power to resist the adoption of a new idea. However, economic forces will sooner or later compel industry to discard the fancy practices of the engineering department and will insist on maximum simplicity and minimum cost in engineering drawings. Those who take the lead in thus reducing engineering costs will be in an enviable position. Leadership always carries with it distinction and recognition.

George F. Jordenkolt

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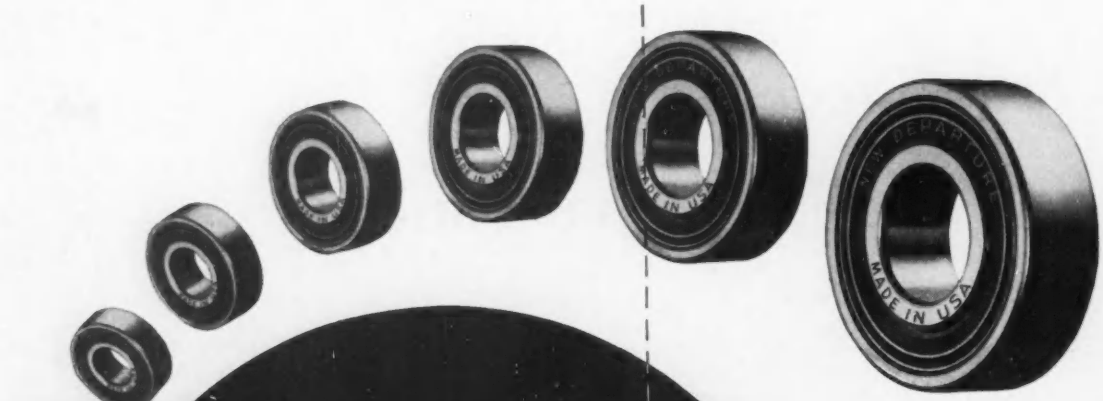

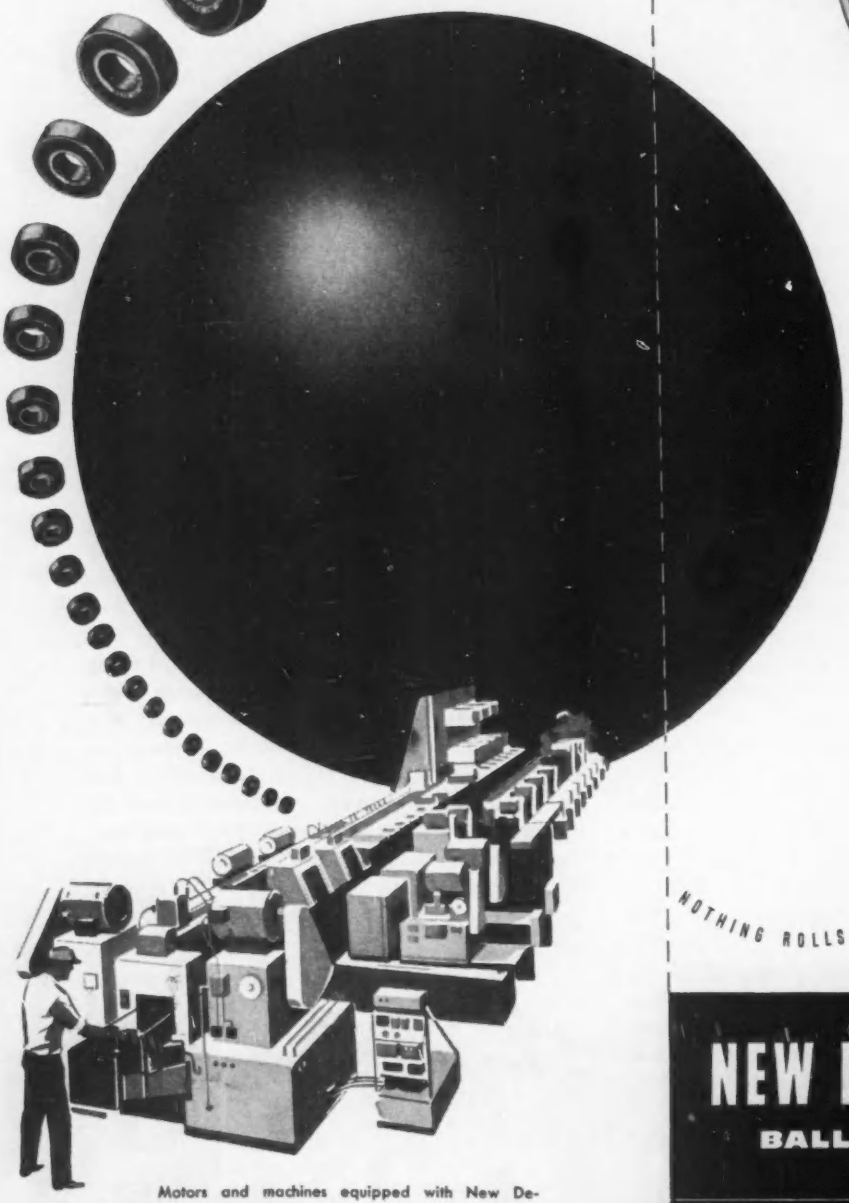

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The *Facts* About Automation

H. F. DEVER

Much has been written and said recently about automatic machines and factories. Some of this has been sound; a good portion has not. As an instrument manufacturer, H. F. Dever, President, Brown Instrument Division of Minneapolis-Honeywell Regulator Company, has watched the automation trend grow. Here are his views on:

- **How far automation will go.**
- **Who are the biggest users.**
- **What are the major design problems.**
- **Who will design tomorrow's factories.**

P.E: Since 1945 business management has gotten deeply interested in automatic instrument control —what is meant by that term?

DEVER: To me, it means using an instrument to measure a quantity and, as limits are reached, feeding this information back into some form of control to start an action that will correct any error found in the measurement. The possibilities of what you can do with such an idea are terrific.

P.E: Is that why industry has gotten so interested in the subject?

DEVER: Probably. But a lot of other things helped too. Today, management sees things going on that bring to mind ideas they wouldn't have thought of otherwise—atomic energy is one such thing. In addition, other technological developments made during the war have had a big influence on executive thinking. Certainly there's

". . . Industry and business management see a lot of things going on that bring to mind ideas they wouldn't have thought of otherwise. . ."

". . . Where business used to spend one or two percent of capital funds for instruments, it's now spending six or seven. We think it could go to 10 or even 15 percent. . ."

been a lot of money spent for research—both by the government and industry—to bring to the surface some of the things that can be done with these developments.

P.E: Has the aircraft industry, as a heavy user of instruments, influenced other industries?

DEVER: Not particularly—I would say that electronics played a much bigger role. But even more important are some non-technical aspects that have entered the picture. Don't forget, we've had an inflationary situation; we've been short of manpower; and we've tried to add to our capacity terrifically. The interrelation of those factors has had an important bearing on the desire for automation. For example, if you need manpower and can't get it, you begin to look for something that will do some of the work in place of manpower—things automatic do that. If you have inflation, you begin to worry about the cost of scrap or low quality situations that often can be helped by, the use of instruments.

P.E: Do you think total automation is the answer to such problems?

DEVER: To me, the question of how automatic we are, or how automatic we get, is a very complicated subject. It's primarily an economic question. I don't think there is going to be any such thing as a packaged factory, or that there will be any two factories in the United States exactly alike. But I do believe instruments and other forms of machinery and equipment will be packaged to comprise unitary systems that can be put together in almost any kind of combination to accomplish much more automation than we have now. How soon these will be available, I don't know. Probably the increasing availability will be gradual. But certainly there are many pressures, advantages and necessities that are increasing the speed with which this matter of automation can be accepted.

P.E: Are there any signposts that indicate an increase in instrumentation?

DEVER: In the past 10 years, the increase in expenditures for instruments has been twice as great as the increase in general capital expenditures. In other words, where business used to spend one or two percent of capital funds for instruments, it's now spending six or seven. We think it could go to 10 or even 15 percent as developments make it economically feasible for people to use more instruments.

P.E.: In what fields have these increases been most noticeable?

DEVER: It's difficult to sort that out on a 10 year basis. All the major industries are using more instruments. Some are more adaptable to it than others; some are under more pressure to use them than others; some of them naturally go in for continuous process manufacture as contrasted with batch process. On the other hand, some things are never going to be made on continuous process—they just aren't economically sound that way.

The industries which do tend to continuous processing—like petroleum and chemicals—are the greatest users of instruments and other forms of automation. Those which have done less about it are food, maybe textiles, and certain forms of the mechanical type of field like metalworking. But strangely enough, metalworking is the place where you hear a great deal about this automation.

P.E: Do you think automation is practical in metalworking?

DEVER: I feel it's difficult to be dogmatic about it and say yes or no. I think you can do anything you start out to do if you want to spend the money on it. But I don't know that it is going to be economical in very many metalworking applications.

". . . All major classifications of industry have shown progress in this accent on things automatic. Some industries are more adaptable to it than others. . ."

". . . Automation is an economic problem of whether you replace a man or keep him around to do something. Safety might contribute to its adoption. Quality may be involved."

However, what degree of automation do you talk about when you consider some of the machinery that has been with us for a long time? For instance, the A. O. Smith Company in Milwaukee has a machine that makes automobile frames—to me, that's a terrific job of automation. and it's been with us for many years.

P.E.: What are the requirements for such equipment to be economical?

DEVER: I would say either high production, a repetitive operation, or an operation that cannot be done by human hands. For instance, if there are a multiplicity of things that must be done in a coordinated fashion; if specifications to be met are beyond human ability; if fatigue makes it undesirable for human operations; or if scrap rates and rejects are excessive.

There are other things, too. Safety might contribute to making automation feasible. In atomic energy, many thousands of dollars were spent to develop laboratory gimmicks so that people could reach into radioactive areas and do this or that with ingenious extensions of their hands and arms. It was necessary because it would be very dangerous to let humans do some of the operations directly.

I think quality may be involved. Development of mass spectrometers, infra-red gas analyzers, and many other forms of quality determining and sensing devices is an indication that instruments will be able to measure a process in terms of its quality automatically to a much more effective degree than can be done manually. The next step is to add control. If we can analyze it and determine what is necessary, let's add a device that will open and close the valve, or start and stop the motor—thus making it completely automatic.

P.E.: Isn't that merely a servo mechanism?

DEVER: It depends on what your definition is. A servo mechanism—in its strict sense—is some kind of motor or other mechanism that, receiving a signal or direction from something else, mechanically positions some object. On the other hand, when I say servo mechanism techniques, I'm thinking about a war-developed method of analysis which, through a lot of high powered mathematics, permits you to rate the performance of equipment in advance.

P.E.: How does this fit into the problems that designers in each industry will have to solve?

DEVER: Instrumentation is only part of the problem. The automation problem involves applying servo mechanism techniques to make best use of the instruments. It also requires similar data on other pieces of equipment. It is necessary to have tanks, pumps, valves, heat exchangers, and other components that make up a complete system rated in servo mechanism technique factors. Then, everything can be matched out properly on an engineering basis to carry out the process at the optimum efficiency. When this is done, it will be possible to design a plant or process in advance and predict its output to a much higher degree than is possible now.

P.E.: Who is going to design these plants or processes?

DEVER: All of us who make equipment are going to design our particular part of them. Coordination will be the real problem because some one will have to make the selection of components.

P.E.: Since instruments are such an important part of this —do you think the instrument manufacturer will do the coordination?

DEVER: I think we will help but I don't believe it would be economically sound for us to do it all. It's going to

". . . Coordination is the real problem because someone will have to make the selection of components. The answer is a disinterested equivalent of a consulting engineer. . ."

". . . I doubt that very many computers are going to turn out to be big mechanical brains. They are not economical. You've got to make them smaller, simpler and more specialized. . ."

cost all of us a lot of money to keep abreast of these techniques and know what our own product can do. We might try to have on our staff a group of people who are consultants on this sort of thing and we might try to sell their services for a fee. Some people would buy it. But in the long run, I say it will have to be people that are disassociated from the manufacturers who will provide the service.

P.E.: Is anything being done today that could be compared to this technique?

DEVER: Yes—what we call systems engineering. Our company and everybody else that has a stake in this thing are willing to do a lot of system engineering when somebody will let us go into his plant, study it, and make recommendations as to what our kind of equipment can do for him. That's how we sell our products. And we'll get better at it: we'll be able to tell our customers more about it, we'll be able to tell them where allied things should be purchased or what should be done in order to make instruments effective. But, as I've said, that isn't the final answer. The final answer is some sort of disinterested equivalent of what you might call a consulting engineer—someone trained in servo mechanism techniques who knows where to go to get the information, how to draw it together, how to specify it, how to supervise an installation and things of that kind. That's the item that's missing in the picture today.

P.E.: Are people with such training available?

DEVER: A few of them are. We have some people who understand servo mechanism techniques and there are some independent engineers here and there. Most of these engineers may be in the universities today.

P.E.: What effect will this have on individual products?

DEVER: We are all going to have to know enough about such techniques to be able to say we have designed and tested our product in such a manner that we know the characteristics are thus and so. Over a period of time the specifications which we and everybody else use will be spelled out with new types of data that are not used today. Now we talk about accuracy or response time or pounds per sq in. pressure, but some day we'll have other characteristics specified so that when we describe our equipment it can be selected in relation to other outfits—pumps, tanks, heat exchangers and so forth. We may even find that when we measure things that way, we have to redesign our products because they aren't good enough.

P.E.: In which fields do you anticipate the greatest development—electronics, pneumatics, hydraulics or mechanical components?

DEVER: Electronics by far. Sure, we have a terrific stake in pneumatics—lots of our control systems are pneumatic with air-operated valves, and things like that, but there is nothing very new about it. It hasn't got, it seems to me, any spectacular future. I think pneumatics is much closer to its ultimate than is electronics.

I don't want to be misunderstood: I'm not saying that either hydraulics or pneumatics are going to disappear from the picture. I think there will be further refinement of them—but it will be a comparatively routine improvement as contrasted with what may happen in electronics. For instance, there's the transistor and the possibilities of what it may do for us. Transistors will certainly make electronics a great deal easier to maintain. They've opened up a whole vista of new thoughts for us. I don't see these same visions in hydraulics and pneumatics.

P.E.: One of the most interesting developments in electronics has been the evolution of computers and their use—how do you anticipate they will fit into automation?

". . . There will be instances where it takes so much mechanism to accomplish a result that automation isn't economically sound. . ."

". . . Instrumentation in Europe generally is a long way behind us. I don't think the problems have been technical in nature, rather there have been economic situations . . ."

DEVER: A computer picks up measurements, characteristics, or facts from somewhere, after which it integrates, multiplies, or divides to provide an answer. Intelligence has to be fed into the computer from someplace—one or more sensing devices. For computers to obtain a real place in the future, they will need new and improved sensing devices.

I doubt that very many computers in industry are going to turn out to be the tremendous mechanical brains that have been widely publicized. Probably most of them are going to be electronic, but they aren't going to be the big things you read about today. They will have their place, but for general use they're just not economical; you can't shelter many devices that big. So you've got to make them smaller, simpler and more specialized. Design them in assemblies that can be put together in different ways—in a building block fashion. Then you can do anything you want to by the day you tie these things up.

P.E.: Do you think there are any industries that will not be able to take advantage of these developments?

DEVER: Undoubtedly there will be instances where it takes so much mechanism to accomplish a result that it isn't economically sound. Some things—like putting a stopper in a bottle—can always be done by human means a great deal more easily and cheaply than by automatic means.

Or, strangely enough, I don't see how it will be practical for us to try to do many things automatically. We make equipment in which it is uncommon to build very many of any specific model. We keep changing them. Every application is different, so each instrument is different than the next. To show you what I mean: We counted the number of documents—bills of materials, parts lists, blueprints, and so forth—originated for our Electronik Potentiometer. Our engineers counted over 6,000, from which they could make 1,900,000 varieties of electronic potentiometers. In a situation like that, you have to use manual means to do a lot of things, even if you are automatic minded as we are.

P.E.: You've just come back from an inspection trip to Europe—How does the instrumentation picture look over there?

DEVER: By and large, instrumentation in Europe is a long way behind us. But I don't want to imply that there aren't some good instrument outfits in Europe—because there are.

P.E.: What appears to be holding up Continental development?

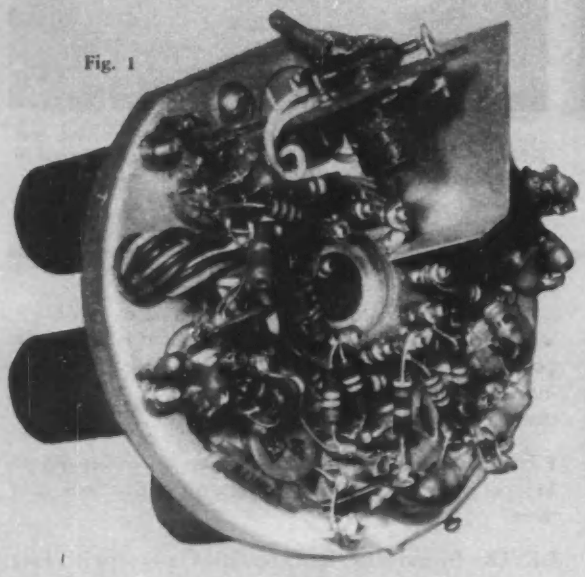
DEVER: I don't think the problems have been technical in nature, rather there have been economic situations which haven't made it feasible for them to develop instrumentation as far as we have. Over there, each country is like a little compartment with its own regulations, customs, exchange problems, and tariffs—all of which limit markets. As a result, they don't have any substantial production. In addition, languages pose a problem. They don't exchange information as freely as we do. I suspect if somebody were to wave a wand over Europe and remove all the barriers, trade would pick up terrifically and be a good deal more like ours.

P.E.: What countries have advanced the farthest in their use of instruments?

DEVER: England probably represents, instrumentwise, the best example of advanced thinking in Europe. In terms of general use, Belgium and the Netherlands are probably farthest advanced. Germans will argue this with me since they have been manufacturing all kinds of scientific instruments for years but their instruments tend to be simple.

Fig. 1—One stage of an electronic submarine detector device as constructed by conventional methods (left) and by module circuits and etched copper mounting plates (right). Production of the latter unit is completely mechanized except for hand mounting of the modules on the base plates.

Fig. 1



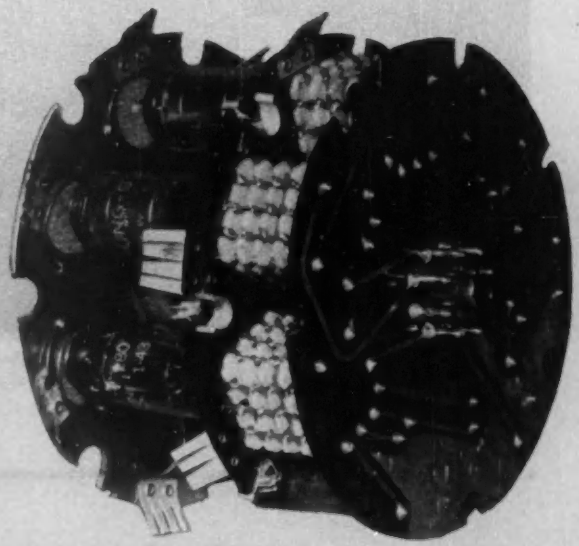


Fig. 2—The circuitry of complex assemblies such as the radio altimeter and radar amplifier assembly, shown here, can be changed in a few hours by changing the printing stencils, stacking arrangement, and test limits for the modules. The altimeter is at top right.

Project Tinkertoy: *It Changes*

Although much has been written on Project Tinkertoy, the NBS development covering automatic production of electronic equipment, here is the first complete data on the system, the components, and the production line. This article is based on information supplied by J. G. Reid, Jr., Chief, Electronics Division, National Bureau of Standards; R. L. Henry, NBS Project Leader, under whose supervision the system was developed; and C. C. Rayburn, Asst. Project Leader, also of NBS.

COMPLETE DETAILS of Project Tinkertoy, the system for automatic production of electronic equipment sponsored by the Navy's Bureau of Aeronautics and developed by scientists at the National Bureau of Standards, have now been made available. Disclosed to the public in the latter part of September and described in essence in the October issue of *Product Engineering*, this system, for the first time, makes possible: (1) machine production and assembly of electronic equipment; (2) complete circuit conversion flexibility; and (3) a reduction in lead time on complex assemblies from months to hours.

Production rates are much higher than with hand methods; equipment reliability is far greater, particularly with respect to shock and vibration; and reliability is increased. In fact, all the advantages of printed circuitry and completely automatic production of equipment ranging from television and radio chassis to aircraft radar systems, long envisioned by the electronics industry but held back by the inflexibility of conventional design techniques, have been realized.

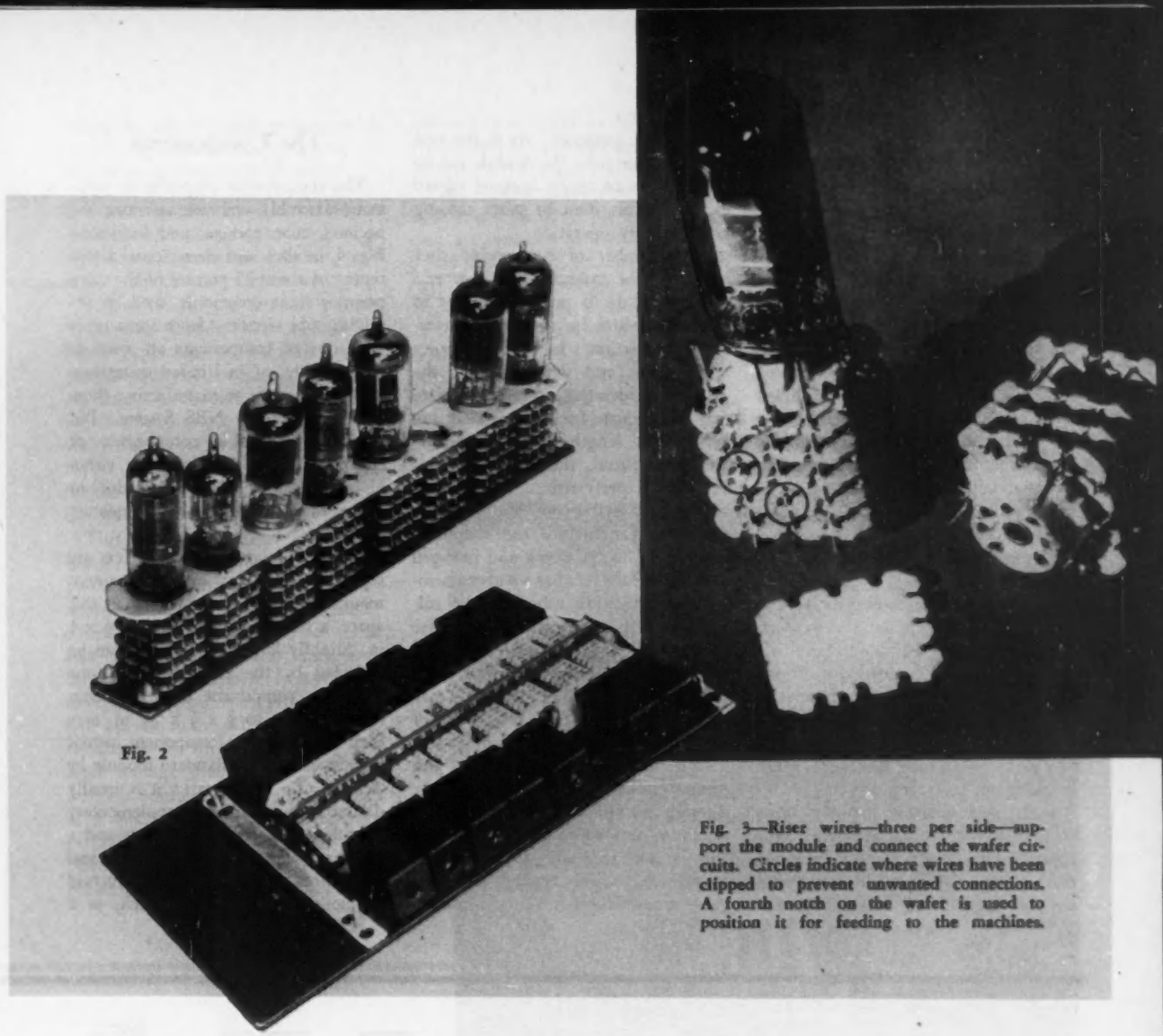


Fig. 2

Fig. 3—Riser wires—three per side—support the module and connect the wafer circuits. Circles indicate where wires have been clipped to prevent unwanted connections. A fourth notch on the wafer is used to position it for feeding to the machines.

the Electronic Design Concept

The machines developed by NBS are incidental; they can, and probably will, be modified or redesigned by individual manufacturers. The heart of the development is the concept of module circuits.

The System

The basic problem of mechanized production is to retain designers' freedom to change circuits—characteristic of conventional hand-assembly methods—while increasing the standardization of the product and the uniformity of components required for simple repetitive production operations. The concept of modular design, the assembly of a complete equipment by reproduction of a simple basic unit of uniform physical dimensions, fulfills both requirements. Complex electronic equipment and systems, Fig. 2, are assembled from a number of major functional subassemblies. These subassemblies, in turn, are constructed from a number of the standard basic physical units or modules (Fig. 3).

The desired degree of standardization with respect to machine handling problems was obtained by limiting the size and physical development of components to permit their being mounted singly or in multiple on standardized ceramic wafers. The modules are normally constructed of five such wafers including a tube socket wafer.

The bare ceramic wafers are approximately $\frac{7}{8}$ by $\frac{7}{8}$ by $\frac{1}{16}$ in. thick and have three small notches equally spaced on each side. Resistors, capacitors, conductors, tube sockets, and similar electrical components are located on the two flat faces of the wafers. Printed silver wiring, fired

onto the surface of the ceramic wafer, interconnects components, or connects components to one or more of the twelve wafer notches.

The wafer-type assembly of components permits them to be stacked one above the other on approximately $\frac{3}{16}$ in. centers. In this position, the notches on all wafers are aligned, and rigid metallic conductors are fitted into them. Each vertical conductor, or riser wire, is soldered to one metallized notch on each wafer. This permits the interconnection of wafer components in a wide variety of circuit arrangements and enables the wires to serve as structural members as well as electrical conductors.

In the case of a 5-wafer module, the resulting structure is $\frac{7}{8}$ by $\frac{7}{8}$ by $1\frac{1}{8}$ in. high, including miniature tube socket. It may contain as many as seventeen components, for which 60 terminals and any one of 24 external connections may be used. It weighs approximately 0.6 ounce, but is a strong assembly, capable of supporting static loads up to 200 lb on its tube socket, or 1,000 lb along its transverse axis.

Such machine-made modular units can replace individual electrical components. For practical and economic reasons, a machine-made unit need not be capable of disassembly for maintenance purposes. As in the case of an electron tube, the module can be discarded as an entity, without regard to the specific item or parts causing unsatisfactory operation.

Any member of the twelve riser wires may be extended at either end of the module to permit assembly to laminated plates for support and electrical connection. In low frequency applications, and where cost is the prime consideration, one such plate may be adequate for the intended use. Where lead lengths and coupling effects are critical, the dual-plate construction is preferred.

The NBS system was designed for all types of miniature and subminiature tubes. Special seven and nine-pin sockets are fabricated as a wafer assembly. Subminiature tubes can be soldered directly to riser wires and base plate conductors, or can be attached to adaptors having miniature tube pin configurations. These adaptors may then be plugged into the seven or nine-pin sockets adapted to the wafer design. The range of tube types and component capabilities range from d-c through the vhf range. However, the system is limited in uhf applications and is not adaptable to microwave frequencies where coaxial or wave guide transmission is being applied.

The Components

The components adaptable to automatic assembly embrace resistors, capacitors, tube sockets, and inductors, Fig. 4, in sizes and characteristics that represent about 75 percent of the components most commonly used in receiving-tube circuits. Since some types and sizes of components are used so infrequently, or in limited quantities, it is not feasible to manufacture them especially for the NBS System. But commonly available components of conventional construction may either be included in the standard module or packaged separately as a supplementary module.

In the standard module, wafers are separated by $\frac{1}{4}$ in; any component mounted on a wafer must fit in this space, a volume of which is $\frac{5}{8} \times \frac{5}{8} \times \frac{1}{4}$ in. Slightly larger components can be included by the elimination of one wafer; a component having dimensions as large as $\frac{5}{8} \times \frac{5}{8} \times \frac{7}{16}$ in. may then be used. If a component cannot be included in the standard module by removal of a single wafer, it is usually desirable to construct a supplementary module, using only two wafers and a few riser wires. The two wafers and riser wires provide a simple structure of modular dimensions, which, as a

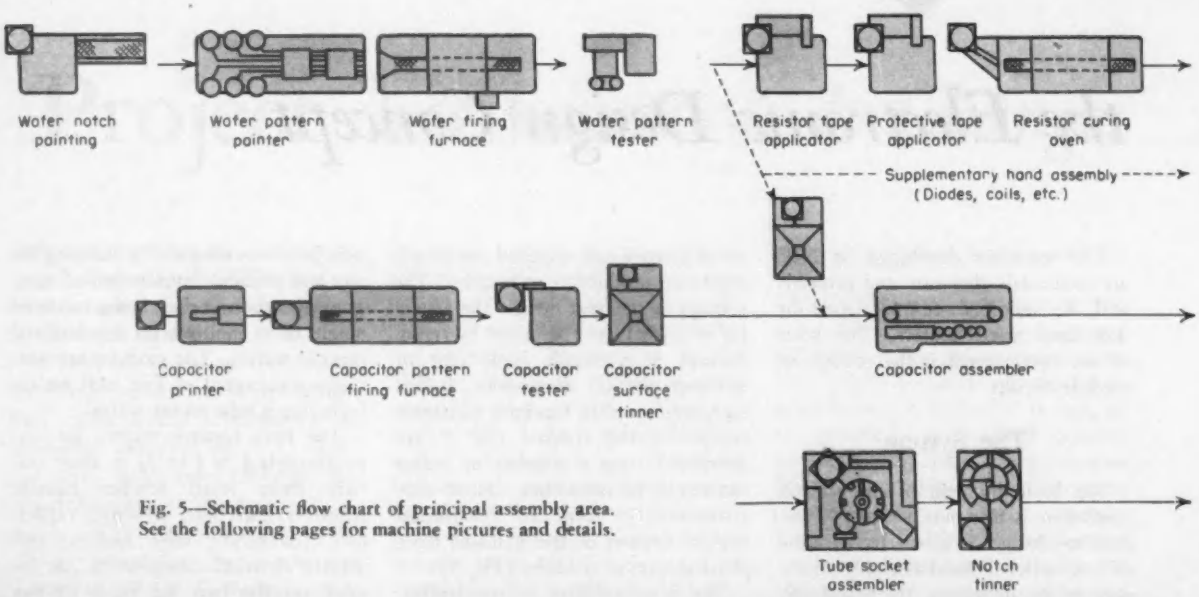


Fig. 5—Schematic flow chart of principal assembly area. See the following pages for machine pictures and details.

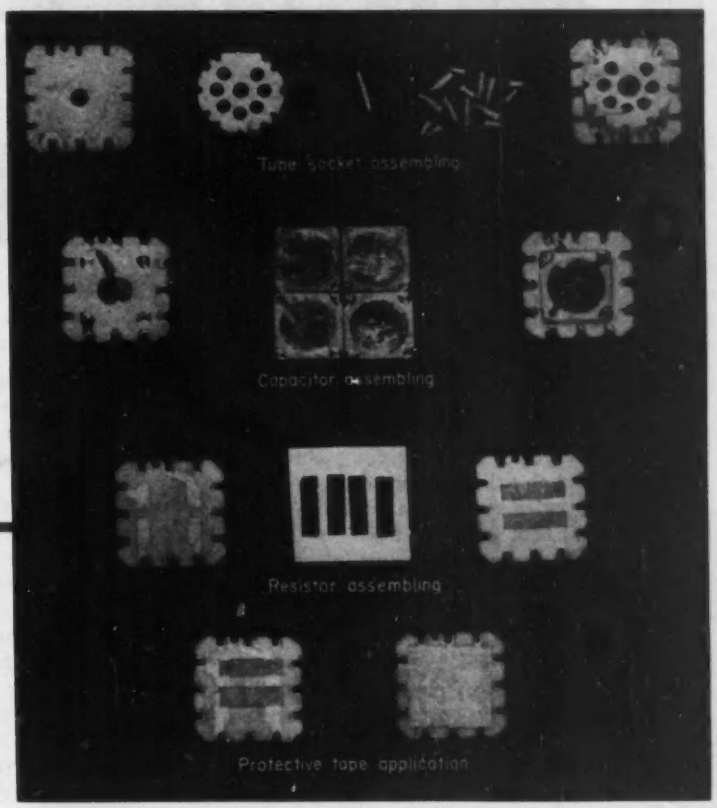
mounting and terminal device, serves to simplify hand-assembly operations and conventionalize "lead dress".

Resistors. Carbon composition resistors of special adhesive film-type, evaporated metal precision resistors, and wire wound resistors are used.

The adhesive tape resistor is made by coating flexible, heat-resistant asbestos paper tape with a carbon composition-electrical resistance paint formulation. As a result, the tape resistor has its own pressure-sensitive adhesive which bonds it securely to its wafer support and makes electrical connection to the printed silver electrodes on the wafer surface.

This system is unusual in two respects: its adhesive tape construction permits fabrication of a batch of resistors of similar electrical resistance characteristics that may be pre-tested and calibrated before use; and, since the element is made of heat-resistant materials, a resistor is produced that will operate with good stability under conditions of high temperature and high wattage dissipation. The heat-resistant adhesive tape resistor is rated at ¼ watt load in ambient temperatures as high as 150 C and is not permanently damaged by external temperatures of 200 C. As many as four adhesive tape resistors, with a total dissipation of one-watt of electrical energy, can be applied to each wafer.

Each resistor is approximately ⅛ in. wide and ½ in. long. It is laid down over a pattern of printed silver electrodes that are 0.3 in. apart. In this size, the system covers a resistance range of 10 ohms to 10 megohms. At the present state of development, values between 40 ohms and 3 megohms are more easily controlled in production than either low or high values. Also, for purposes of compensating for variations in material and preparation that normally take place, a slight adjustment of width of tape is made prior to application by machine. Performance with respect to electrical characteristics such as noise, voltage coefficient, and temperature coefficient equals those of high grade carbon composition resistors; the military performance requirements, as established by JAN-R-11, are met or exceeded. In particular, the resistance to deterioration under conditions of high ambient temperatures and high



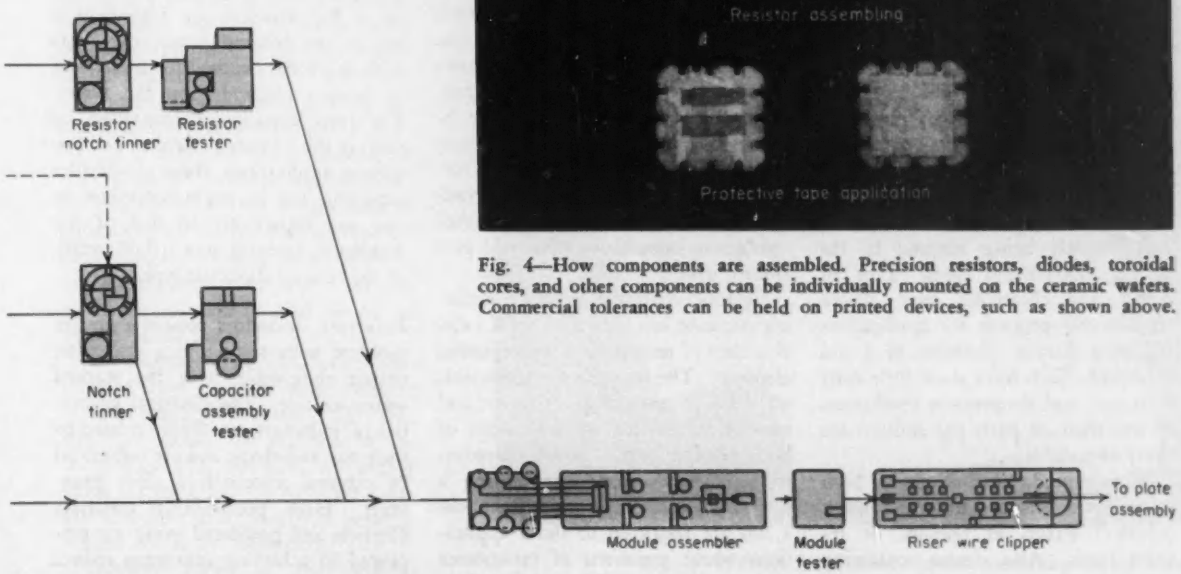


Fig. 4—How components are assembled. Precision resistors, diodes, toroidal cores, and other components can be individually mounted on the ceramic wafers. Commercial tolerances can be held on printed devices, such as shown above.

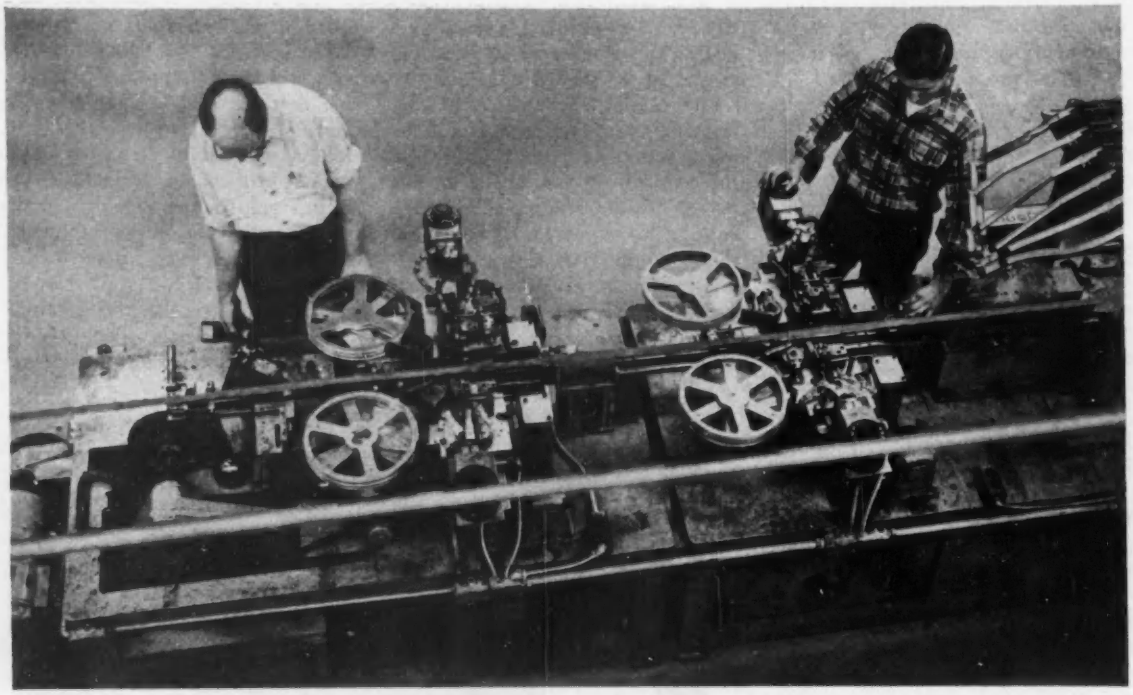


Fig. 6—Module assembly machine, showing feed chutes, lead wire reels, and the two soldering stations.

wattage dissipation exceeds that of comparable types.

Because the tape resistor is a carbon composition, it is not in the precision category. Although values can be adjusted or selected to close tolerances, such resistors will not be manufactured to tolerances better than 10 percent. Although four resistors can be applied to a single wafer, the probability of all resistors being within tolerance is reduced; therefore, no more than three resistors are normally placed on each wafer, and high value resistors are applied singly wherever possible.

Precision resistors of evaporated metal films and cracked carbon films are currently being adapted to the system. Evaporated metal films of nickel and chromium have shown considerable promise for applications requiring resistor tolerances of $\frac{1}{2}$ and 1 percent. Such films show little drift with age, and temperature coefficients of less than 20 parts per million are easily obtainable.

Wire wound, close tolerance, high wattage resistors are produced using modified wafers as bobbins or resistor cards. Also, forms containing flat coils of resistance wire, as well as the more miniature versions of commercially available wire wound elements, can be produced. Values up to 10,000 ohms per wafer can be obtained.

Capacitors. Ceramic and plastic-film dielectric materials are used almost exclusively. The ceramic dielectric capacitors are in the form of 20-mil thick sheets, approximately $\frac{9}{16}$ in. square with printed silver electrodes on both faces. Capacitor values ranging from 5 mfd to 0.01 mfd can be obtained by varying the dielectric constant of the ceramic material by formulation and processing. Minor variations in electrode sizes produce small changes in capacitance value and give control over processing variables.

Ceramic dielectrics having a dielectric constant less than 100 are a valuable class of temperature compensating elements. The temperature coefficients of bodies in this group are linear, and may be formulated in small steps of both positive and negative characteristics. Ceramic dielectrics having a dielectric constant greater than about 1,200 are restricted to those applications where variations of capacitance with temperature will have little effect.

The ceramic dielectric capacitors are supplemented by flat forms of multilayer polyester* film and metallic foil. In general, these equal the performance of high grade paper capacitors over the temperature range of —50 C to +125 C. From 0 to 85 C they approach the quality of mica capacitors. Such capacitors are wound on a flat mandrel, or folded in a manner to produce square capacitors with electrodes exposed for connection to printed electrodes on the wafer. The total capacity is controlled by varying the number of layers. For low voltage applications, these plastic film capacitors can be made equivalent in size and capacitance to that of the maximum capacity unit (0.01 mfd) of the ceramic dielectric type.

Inductors. Inductors present a greater problem with respect to a systematic design compatible with the stacked wafer module. The electrical properties of inductors are closely related to their size and shape and are influenced by external materials in close proximity. High permeability materials (ferrites and powdered iron) are employed in achieving maximum induc-

* Trade name, Mylar, E. I. Du Pont de Nemours & Co., Inc.

tance per unit of volume. These materials, or the use of a toroid, assist in controlling external fields and the affectation of adjacent component wafers and riser wires. Inductances of up to one microhenry can be mounted in the space provided by the standard separation of wafers. Larger values require either the elimination of one or more adjacent wafers or the construction of a supplementary module. For tuned amplifiers in the five to 100 megacycle range, flat spiral inductors (printed or etched from foil, flat solenoids, or toroids mounted on wafers) can be used. Larger inductance values and inductors associated with most types of oscillators should be mounted externally to the module.

The Production Machines

The production facility is composed of a mechanized assembly line, Fig. 5, and three principal supplementary facilities that produce ceramic parts, tape resistors, and interconnecting plates for the modular circuitry.

The supplementary facilities are distinguished in operation from the mechanized assembly line. They perform independently to produce and stock-pile circuit elements with only a casual regard to the assembly line production schedule. Conversely, the assembly line obeys precise scheduling. This is necessary, not only to minimize stockpiling of semi-processed products on the line, but also to permit rapid conversion of the line to other modular construction.

Production programming of the system is simple. A work sheet, Fig. 7, on which is printed blank outlines of wafers, is used to schedule production. Each sheet contains the top and bottom outlines of six wafers with appropriate numbering to identify each notch in the wafer, each riser wire, and the electronic component that is to be placed on the wafer.

The engineer translates his conventional wiring diagram to a modular design working diagram. On this sheet, he marks the position of the component and indicates its proper value and the allowable tolerances. He also indicates how the circuits between wafers are to be connected.

Advance copies of the modular work sheets are dispatched to the supplementary facilities. These facilities may fortify their inventory of stored parts required for this production run in advance of the actual assembly schedule. Likewise, copies are distributed to automatic testing stations so that standards can be prepared against which the machine-made electronic assemblies may be compared. Other copies are distributed to the machine operators to keep them informed of setup requirements.

Another item instrumental in production control takes the form of a standard punched control card. The control cards are the triggers that set the machine line in action. One card is supplied for each wafer of a modular design. Usually, all cards pertinent to one modular design are submitted simultaneously to the line. The card serves the following functions:

1. Informs operators of the initiating time.
2. Informs operators of exact quantity to initiate.
3. Accompanies parts transfer box, identifying the wafer batch as it is processed through the line.
4. Provides machine setup information from modular work sheet identified by the wafer file number on the card.
5. Provides space to record yield information at each automatic testing station.
6. Provides space to record each processing date and time with the operator's initials confirming completion of each process.

When all wafers of a module converge in the module assembly, the cards are returned and filed as historical information for subsequent scheduling. Another punched card continues with the batch of modules until they have been connected in the plate assembly. This card sets up a module tester and serves to record production information in a manner similar to that previously described for the wafer.

For purposes of explanation, the assembly line is divided into four functional sections: (1) metallization; (2) component assembly; (3) module assembly; and (4) plate assembly.

Metallization is a name given to the application of a special silver paint and its subsequent baking at high temperatures to form electrically con-

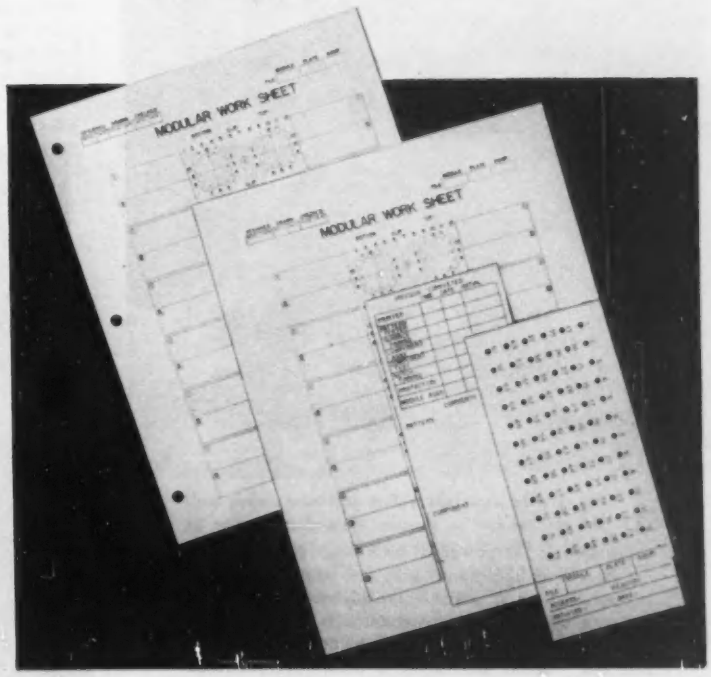


Fig. 7—A design work sheet controls production in the main assembly area and keeps supplementary facilities advised of wafer, tube socket, resistor tape, stencil, and ceramic body requirements. Punch card controls the automatic testing machines.

ductive films. Circuits are printed on the wafers, the notches are coated, the printed electrodes and leads are applied to the capacitors, the bodies are fired in a furnace, and the circuits are automatically inspected.

In the component assembly machines, the resistor tapes, capacitor bodies, and tube socket parts are brought together with the ceramic wafers. Only one type of component is placed on each wafer, thereby avoiding the necessity for cross-feed between the component lines. After the capacitors and resistors have been assembled and tested, they converge with the tube sockets at the module assembler.

At this point, the operator checks the corresponding modular work sheet to determine which group of wafers should be placed in each feeder bowl. The channel through which the wafer is fed determines its position in the modular stack. Six vibratory feeders issue the wafers down chutes to a central discharging position. The chutes converge and twist to vertically align the wafers in their final stacked relationships. A holding fixture traverses directly beneath the loading position, and clamps the wafer array after it is released from above. The loaded fixtures are then chain-driven to the first soldering station where specially designed soldering heads approach the stack, melt the notch solder and force riser wires into the notches while simultaneously cutting the wires from the reeled supply. The module is rotated 90 deg as it proceeds to the second solder station where the remaining six riser wires are applied in an identical manner. A mechanism at the exit end of the assembler removes the

The Automatic Machines

1. The stealite porcelain wafers and tube socket bodies are formed in presses somewhat similar to those used in the powdered metallurgy process. They are then fired in a tunnel kiln and inspected. Wafer bodies are held to a maximum thickness of 0.071 in. and to a width of 0.875 ± 0.008 inch. These ceramic facilities are not keyed directly to the main production line. Wafers and capacitor bodies are produced and stored for future use, as are tube sockets and resistor tapes.

2. Wafer notch painting is the first metallizing operation. The wafers are carried past four sets of notched wheels that apply a silver conductive paint. The wheel sets, which are located on all four sides of the wafer passage, consist of three cork wheels. The peripheral velocity of the wheels equals the wafer's down-travel velocity, thus preventing scraping action. The wafers then fall to a belt which conveys them to a heated zone for drying, and are then transported to the printer.

completed module from the fixture and deposits it in a transfer box.

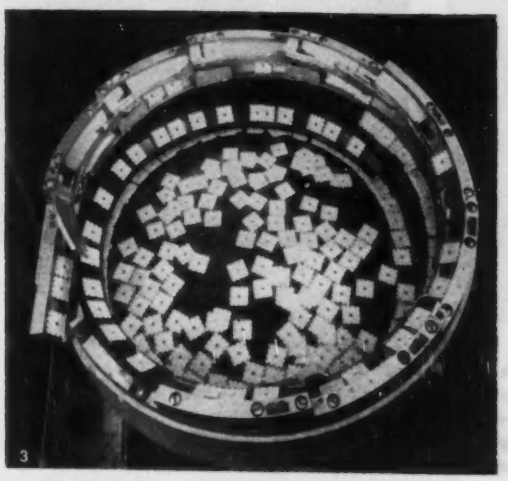
A riser wire clipper severs riser wire segments between wafers or clip riser wire extensions that do not require connection on the plate assembly. The clipping action is accomplished by preset knives which are actuated by solenoids as the module is indexed past the clipping stations.

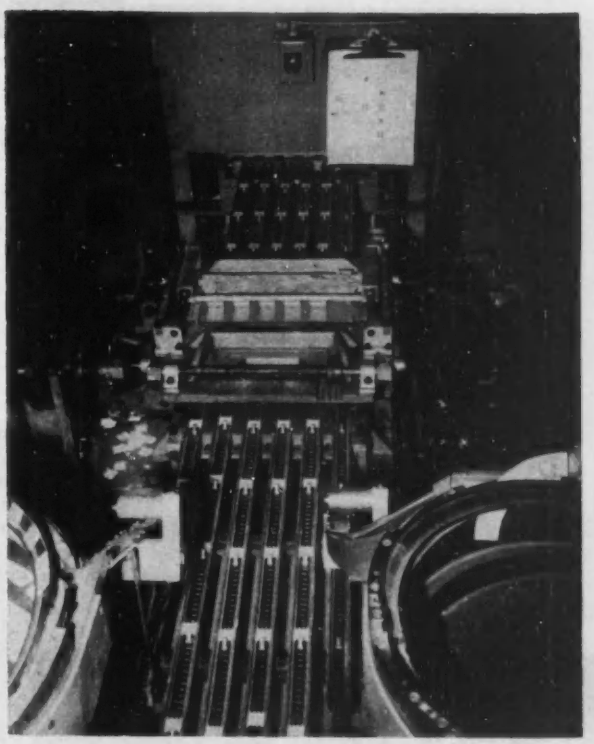
Actually, prior to wire clipping and plate assembling, the modules are carefully checked by a module tester to verify the correctness of their construction. This instrument automatically operates on a 7.2 seconds cycle. Each component in the module is checked twice during the test cycle to assure its correct placement and connection. This includes verification of the proper riser wire-tube pin connector junctions. Should any fault be detected in the entire modular construction, its location is visually indicated. Other than its automatic self-test feature, it also records the number of accepted and rejected modules, ceasing operation upon a preset attainment of either.

The assembled module is then transferred to plate assembly, where they are manually placed on etched copper-clad phenolic plates and where the riser wire extensions are pressed through holes in both top and bottom plates. Flux is then applied to the ends of the protruding riser wires, the assembly is placed in a fixture that aligns the plates as molten solder is admitted to each joint through accurately positioned tubes. Sufficient solder remains at each junction when the solder level is withdrawn.

Beyond these operations, conventional production techniques apply.

3. Vibrating feeder, used throughout the line to orient the wafers—according to edge and side and advance them to the machines. The 18 in. dia. 6 in. deep bowl holds as many as 3,000 wafers and can be regulated to feed as many as 2,500 wafers per hr. As the wafers "walk" up the track, they pass indexing segments tilted at 45 deg. If the wafer orientation notch is directly over a locating pin, they fall through a silhouetted opening to a lower collecting ring. Since the wafers may lie in any one of eight possible positions, eight indexing segments are provided. The wafer is rotated or turned after passing each segment until it lies in the correct position and is fed out the exit chute. These feeders are used on all production machines and test equipment up to and including the module assembly machine. This view is of one unit on the pattern printer.





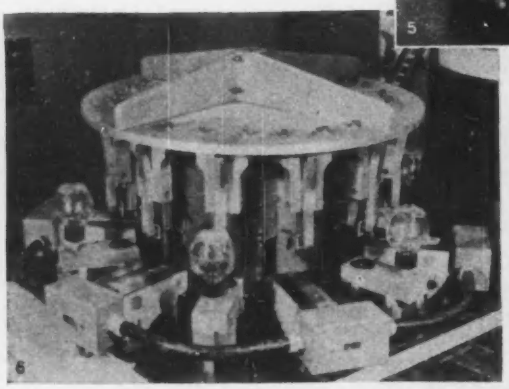
4. From the feeder bowls, the wafers pass through the pattern painter where a squeeze forces silver paint through steel stencils (center) onto one side of the wafer. This is followed by drying, a second printing operation on the second side, another drying operation, and pattern firing in a three-zone furnace.

(continued on next page)

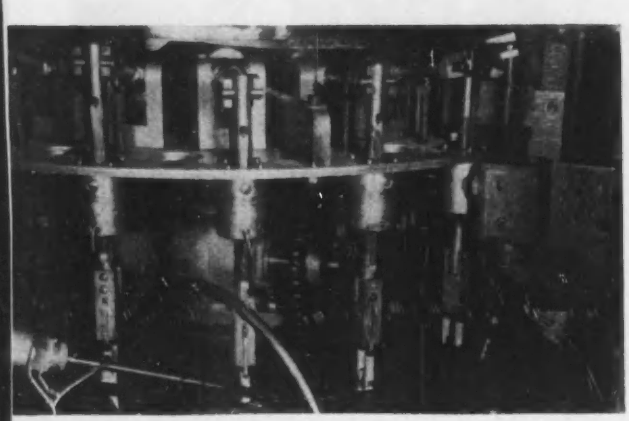
The Automatic Machines (continued)

5. Wafers are carried directly from the pattern tester (see layout) to resistor assembly. In the resistor tape applicator, rolls of tape are placed on spindles located on each side of the path along which the wafers are driven in chain-supported holders. The tape is guided along a series of rollers to an eight-sided applicator wheel. Vacuum acting through small holes in the octagonal wheel holds the tape while it is cut into one-half inch segments, indexed and pressed against the wafer surface.

6. After a protective tape is applied over the resistors by another machine, the resistors are dried and tinned in a notch tinning machine. Identical tinners are employed in each assembly line. In four stages, the assemblies are sequentially immersed in flux and solder.

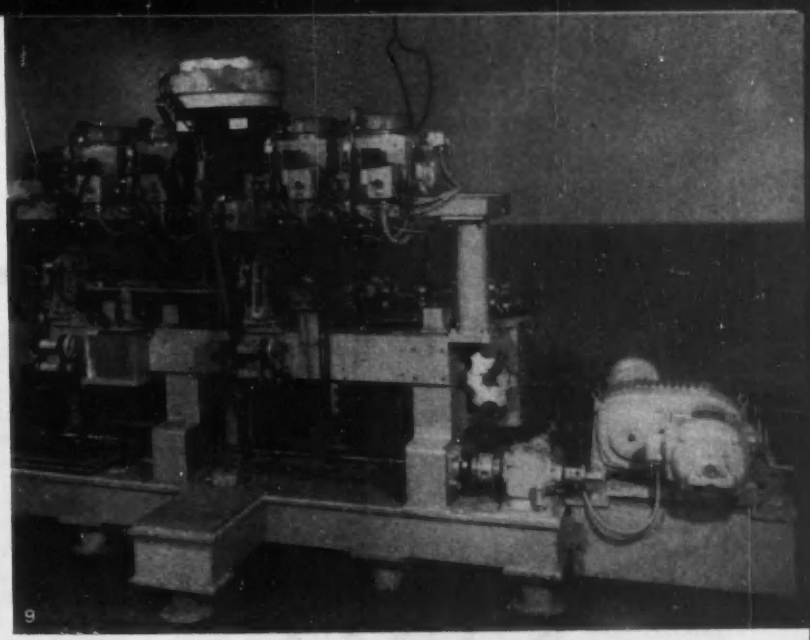


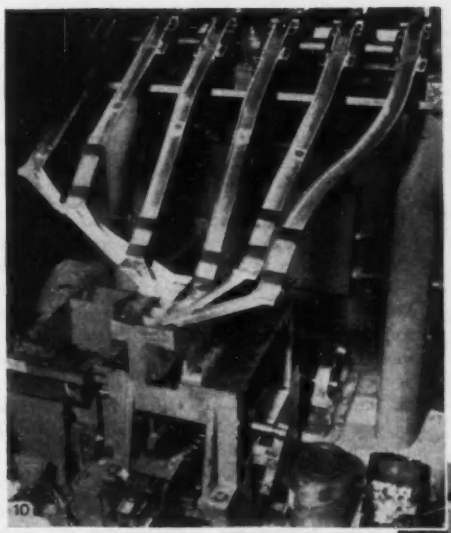
7. The resistor assembly tester is a bridge-type instrument with a rotary table that indexes the resistors under the test position. The value of any of the resistors may be checked within preset tolerances. Between tests, while the assemblies are being transported and inserted, each tester automatically checks itself. Should it fail the self test, it automatically ceases operation and alerts the operator.



8. The bodies are fed into each tinner by a vibratory feeder. At the loading station they are clamped in holding fingers that are mounted around the periphery of a wheel rotating about a vertical axis. As the wheel turns, cams cause the parts to be lowered into fluxing, soldering and washing baths, and finally into a container.

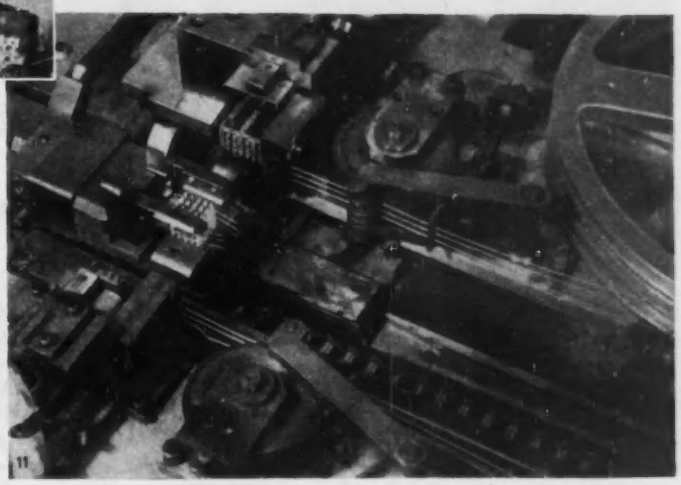
9. In the capacitor assembler, oriented wafers and capacitors slide through chutes that load them on chain driven holders. These insulated holders clamp the surfaces together while carrying the package through two stages of induction heating where all contacting tinned surfaces are mechanically and electrically bonded. An unloading station is sufficiently displaced from the heating station to permit solidification of the molten solder.

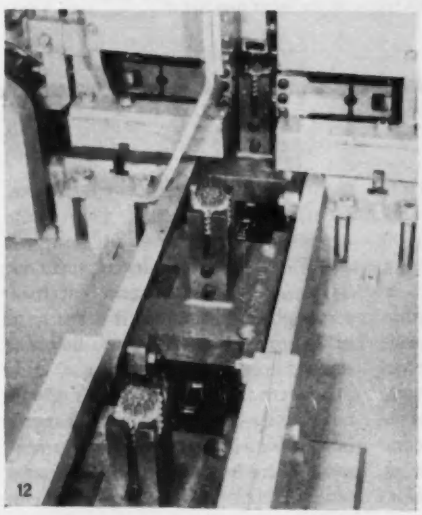




10. Patterned wafers, resistors, capacitors, tube sockets, and other components come together at the module assembler. They are oriented and fed to a fixture where they are stacked in a sequence governed by the chute through which they are fed. This fixture then moves forward to automatic soldering heads where the riser wires are inserted and attached.

11. The soldering operation. Six riser wires are guided from the reels and stopped in the proximity of their final soldered position on opposite sides of the wafer stack. Specially designed soldering heads advance to the stack, melt the notch solder, and force the riser wires into the notches while simultaneously cutting the wires from the reeled supply. The module is rotated 90 degrees as it proceeds to the second soldering station where the remaining six riser wires are applied





12. Exit end of the riser wire clipper, which severs segments between wafers and clips the extensions that are not to be connected to the plate assembly. The clipping operation is performed by preset knives that are actuated by solenoids as the module is indexed past the clipping stations.

What the New NEMA Standards Mean

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SIGNIFICANCE OF NEMA FRAME NUMBERS

The height of the center of the shaft above the plane of the bottom of the motor feet is the *D* dimension. This height in inches is equal to the first two digits of the frame number divided by four. For example, the *D* dimension of the 182 and 184 frames is 18 divided by 4, or 4½ inches. Similarly, the *D* dimension of the 203 and 204 frame is 5 inches. Thus, the shaft height and the diameter are the same for any two frames whose first two digits are the same, as for example, the 324 and 326 frames. Since the diameter of the frame is related to the *D* dimension, it is common practice to refer to the frame as 180 diameter, 200 diameter, 250 diameter, and so on.

The third digit of the number is related to the length of the frames. By referring this digit to a NEMA preferred numbering chart, *F* dimension, which is the dimension parallel to the shaft from the center line of the frame to the center of the bolt holes in the feet of the motor can be obtained.

If the numerical digits of the frame number are followed by the letter *S*, the motor is for direct connection only. If no letter is used, or if the letter *U* follows the numerical digits, the motor is a belted rating. All belted ratings can be used for direct connection, but, with few exceptions, motors, designed for direct connection only should not be used for belted service. The few exceptions are certain fringe ratings which, when supplied with a shaft and bearings of ample size, can be so used provided the pulley or sheave is within definite specified limits of minimum diameter and maximum length.

The letter *U*, which appears in quite a number of the new frame designations, indicates that the shaft has a diameter and length different than the diameter and length of the old frame of the same number. *E*

ON NOVEMBER 12, 1952, the Motor and Generator Section of the National Electrical Manufacturers Association adopted a suggested standard for future design for NEMA design *A* and *B*, 1,800 rpm, 60 cycle, polyphase, open-type squirrel cage induction motors from 1 to 30 HP inclusive. These are the basic ratings from which other speeds, torques, enclosures, and other characteristics are derived. In May, 1953, additional suggested standards were approved, which cover open motors of other 60 cycle speeds down to 600 rpm, totally enclosed fan-cooled motors from 3,600 rpm to 600 rpm, and NEMA design C high torque motors.

Basically this rerating program means that a motor of a given horsepower will in the future be built on a frame of smaller diameter. It will permit the installation of more horsepower in a smaller space and will conserve some critical materials such as special steels, copper, and aluminum.

What Made Re-rating Possible

No one particular development can be pointed to as the one that made rerating feasible; rather it is the result of improvements in design, manufacturing, materials, and testing.

Modern testing procedures give a more exact picture of what happens in a motor as it operates. For example, spots where highest temperatures occur can be determined in or on the core

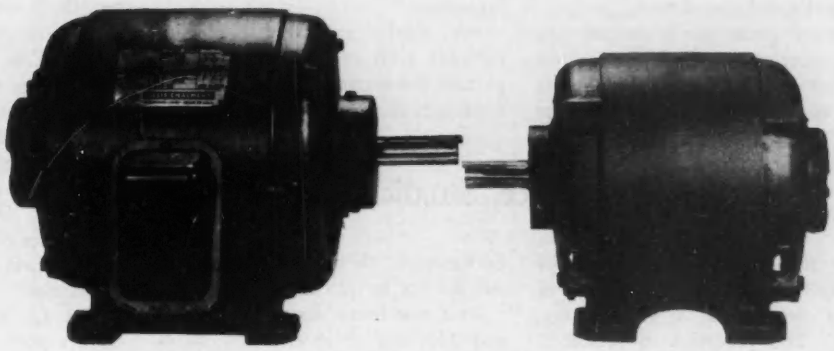
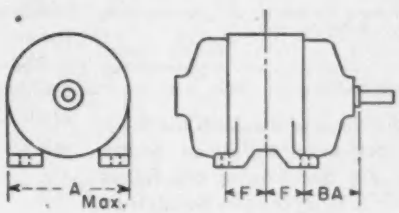


Fig. 1—Old and new Allis-Chalmers designs. Smaller frame size of new units will be extended to other speeds.

HP.	FRAME SIZES			
	OLD			NEW
	1929	1940		1953-4
1	204	203 204	1940 rev.	182 184
1½	224			184
2	225	224		
3	225	225	No change from 1929 frame sizes	213 215
5	254	254		
7½	284	284		254U 256U
10	324	324		
15	326	326		284U 286U
20	364	364		
25	364	364		324U
30	365	365		326U

Fig. 2—Standard dimensional designations for NEMA motors. See discussion on previous page on the significance of NEMA frame numbers. Tables following list frame dimensions for both old and new motors. Data here is for open type, designs A and B polyphase machines.



Standard NEMA dimensions

iron, and in various other locations inside and outside of the frame. Knowing the pattern of temperatures, the designer can make use of all heat removing means, or alter the design to reduce the temperature of the hotter spots. Taking temperature readings with thermocouples is far more accurate than the former method of using thermometers on windings and frame. And of course, designers have learned better methods of removing heat from the windings and core, both by conduction to the outside of the frame and by better ventilation.

Improvements have been made in the quality of electrical sheet steel used for laminations, and in the varnishes and methods of applying them. For a given rating, this means lowered core loss and consequently less heat to remove.

Integral casting of rotor bars, end connectors and ventilation fans, results in a uniform cage, connectors and fans of one material, from which heat can be removed more evenly.

Today insulation is more dense. It is easier to transfer heat through the more compact insulation. The wire with its insulation takes less space. Diameters, taken on the outside of the insulation of No. 15 wire, are:

Heavy vinyl acetal coated	0.06 in.
Single cotton covered, enameled	0.066 in. or 10 percent greater
Double cotton covered	0.0677, or 13 percent greater

When this is converted to area occupied by a single conductor, it becomes apparent that the single cotton covered enameled wire requires 21 percent more space, and the double cotton covered 27 percent more space, than the vinyl acetal coated wire.

Slot cell liners are in general, less bulky, more compact, yet with as great or greater dielectric strength. This, in conjunction with smaller wiring makes it possible to get more copper into a given slot—an important step towards more horsepower in a given frame size. New varnishes, many of which are synthetic, do a better job of impregnation, adhesion, binding and protection.

And finally, improved production methods with better quality control permits the designer to work to closer tolerances than before.

Same Performance, Smaller Frame

The new frame size will occupy roughly 70 percent of the volume of present designs for a given rating, Fig. 1. This reduction in volume is accomplished without decreasing performance standards. The new motors will operate within existing standards for temperature rise, locked rotor and breakdown torques, locked rotor current, slip, and service factors. For example, a 5 hp, 1,800 rpm, general purpose, NEMA design *B*, drip-proof squirrel cage motor, built on the present 254 frame, now meets the following standards:

Temperature Rise	40 C	
Locked Rotor Torque..	185	percent, min.
Breakdown Torque ...	225	percent, min.
Locked Rotor Current at 220 v	90	Amp, max.
Slip	5	percent, max.
Service Factor	1.15	

Under the new standards the 5 hp, 1,800 rpm, motor will be on the 215 frame. Six diameters of old frames covered the range of open ratings from 1 to 30 hp at 1,800 rpm. Five diameters of the new frames will cover the same range. Two frame lengths will be used for each diameter.

In the new series of frames, the shaft height of each frame is approximately 1.15 the shaft height of the next smaller frame diameter. Since the shaft height determines the diameter of the frame, the diameter of successive frames will be in the same ratio. For example, when the 7 in. shaft height of the 280 diameter is multiplied by 1.15 the result is 8.05, which is very close to the 8 in. heights of the 320 diameter.

The 200 and 220 diameters of the old frame series will not be retained. The horsepower ratings that have previously been built in these frames fit into newly established diameters. Furthermore, these old frame diameters did not fit into the 1.15 ratio.

Two new frame diameters, the 180 and 210, appear in the new series. The 180 diameter was established as a new integral horsepower frame to accommodate the smallest integral horsepower ratings. The new 210 diameter will in general accommodate those ratings that have been built on the 220 and 250 diameters of the old frames.

Fig. 2 shows the present frame sizes, and the basic suggested standards for future design for NEMA designs *A* and *B*, 1,800 rpm, 60 cycle, polyphase, open type, squirrel cage induction motors from 1 to 30 horsepower.

The shaft diameter of the new frame, compared to the shaft diameter of the old larger frame which it will replace, is larger in 6 cases, the same in 10 cases, and smaller in 3 cases, which is surprising.

Why smaller in 3 cases? Actually the diameter of the shaft of the old-frame was too liberal for the torques to be transmitted. For example, the 20 HP, 1,800 rpm, open motor will be built on the new 286 frame, which has a $1\frac{5}{8}$ in. shaft. At present it is built on the 364 frame with a $1\frac{7}{8}$ in. shaft. The 365 frame (30 hp, 1,800 rpm) has a $1\frac{7}{8}$ in. shaft, the same as the 364 frame motor. It is logical to assume that the $1\frac{5}{8}$ in. shaft of the new 286*U* frame will be liberal for the torques of the 20 HP, 1,800 rpm, motor. Shaft calculations confirm this assumption. Similar examples can be shown for the other two cases of smaller shafts for a given horsepower rating.

More horsepower on the same frame means that there will be a greater load on the shaft and bearings, particularly radial loads encountered with belt drives. Because of the increased shaft size on a particular frame, the inside diameter of the bearings will have to be larger, thus requiring larger bearings. For a given rating of motor, the size of the bearings on the new frame will probably be about the same as when that rating was built on the old larger frame. Such a statement is general and depends on each manufacturer's designs, since there are no industry standards for the relationship of bearing size to frame size or to the rating of the motor.

Drip-Proof and TEFC Ratings and Frames

The tabulations in Table I shows old and new horsepower and speed versus frame size relationship for polyphase, squirrel cage designs A, B, and C, 60 cycles, horizontal and vertical motors. The first tabulation shows the relationship for 40 C rise drip-proof machines. The second gives the relationship for 55 C rise totally-enclosed non-ventilated and totally-enclosed fan-cooled construction. Frame sizes outside the heavy line enclosure are NEMA designs *A* and *B* motors. Those frame sizes inside the heavy line enclosure are designs *A*, *B*, and *C*. No frames have been approved in the new relationship for the $\frac{1}{4}$ and $\frac{3}{4}$ hp 720 and 600 rpm ratings because of the relatively infrequent demand for these.

The tabulations of frame sizes for open and totally enclosed fan-cooled motors of the new designs show that certain totally-enclosed fan-cooled ratings will be on the same frames as the open motors of the same rating. The limits of this are as follows:

1. All new frames are for speeds of 1,200 rpm down to 600 rpm.
2. 20 hp and smaller at 1,800 rpm.
3. 15 hp and smaller at 3,600 rpm.

The same limits apply to design *C* (high torque) motors except for frame sizes for 20 hp, 1,200 rpm and 15 hp, 900 rpm design *C*, totally-enclosed fan-cooled machines, and for speeds of 720 rpm or less.

Table I—New NEMA Frame Sizes

(Frame Sizes for Polyphase, Squirrel-Cage, Designs A, B and C, Horizontal and Vertical Motors, 60 Cycles).

OPEN DRIP-PROOF, 40 C

Hp	3,600 Rpm		1,800 Rpm		1,200 Rpm		900 Rpm		720 Rpm		600 Rpm	
	Old	New	Old	New	Old	New	Old	New	Old	New	Old	New
½	—	—	—	—	—	—	204	182	224	—	225	—
¾	—	—	—	—	203	182	224	184	225	—	254	—
1	—	—	203	182	204	184	225	213	254	213	254	215
1½	203	182	204	184	224	184	254	213	254	215	284	254U
2	204	184	224	184	225	213	254	215	284	254U	324	256U
3	224	184	225	213	254	215	284	254U	324	256U	326	286U
5	225	213	254	215	284	254U	324	256U	326	286U	364	324U
7½	254	215	284	254U	324	256U	326	284U	364	324U	365	326U
10	284	254U	324	256U	326	284U	364	286U	365	326U	—	—
15	324	256U	326	284U	364	324U	365	326U	—	—	—	—
20	326	284U	364	286U	365	326U	—	—	—	—	—	—
25	364S	286U	364	324U	—	—	—	—	—	—	—	—
30	364S	324S	365	326U	—	—	—	—	—	—	—	—
40	365S	326S	—	—	—	—	—	—	—	—	—	—

TOTALLY-ENCLOSED FAN-COOLED, 55 C

Hp	3,600 Rpm		1,800 Rpm		1,200 Rpm		900 Rpm		720 Rpm		600 Rpm	
	Old	New	Old	New	Old	New	Old	New	Old	New	Old	New
½	—	—	—	—	—	—	204*	182	224	—	225	—
¾	—	—	—	—	203*	182	224*	184	225	—	254	—
1	—	—	203*	182	204*	184	225*	213	254	213	254	215
1½	203*	182	204*	184	224*	184	254*	213	254	215	284	254U
2	204*	184	224*	184	225	213	254	215	284	254U	324	256U
3	224	184	225	213	254	215	284	254U	324	256U	326	286U
5	225	213	254	215	284	254U	324	256U	326	286U	365	324U
7½	254	215	284	254U	324	256U	326	284U	365	324U	**	326U
10	284	254U	324	256U	326	284U	364	286U	**	326U	—	—
15	324	256U	326	284U	364	324U	365	326U	—	—	—	—
20	326	286U	364	286U	365	326U	—	—	—	—	—	—
25	365S	326U	365	326U	—	—	—	—	—	—	—	—

1. The frame sizes outside the heavy line inclosures are designs A and B motors; those frame sizes inside the heavy line line inclosures are designs A, B, and C motors.

* Totally-enclosed, non-ventilated in Allis-Chalmers designs

** No previously assigned standard

The 25 hp 3,600 TEFC new frame is now 326S; it is expected that this will be changed to 326U as shown in tabulation

Some of the smaller sizes of integral horsepower motors on the old frames for continuous duty at speeds of 900 rpm and greater were totally-enclosed non-ventilated. Larger ratings at all speeds and smaller ratings at speeds of 720 rpm and less were generally fan-cooled. There was no definite separation between these in the old frame relation since NEMA standards approved some of the fringe ratings on the same frame in both non-ventilated and fan-cooled construction. As a result, some of the fringe ratings were non-ventilated by some manufacturers and fan-cooled by others. All of the new frames have been approved as totally-enclosed fan-cooled for continuous service.

Dimensions for Replacement of Old Motors

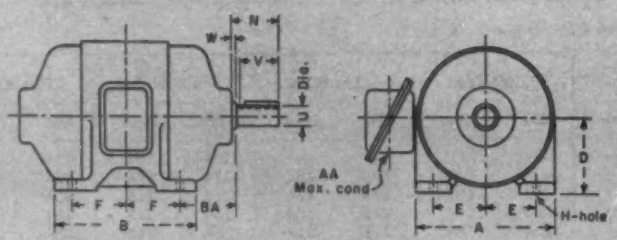
In Tables II and III are listed all the possible combinations (as now approved) of replacement of old frames by new, together with NEMA dimensions for both. The dimensions of new and old frames may be compared. The tabulation will be useful when it becomes necessary to replace an old motor.

For a given frame diameter of new and old, the *D, E, F,* and *BA* dimensions will not change. These dimensions will be identical, for example, on the old 254 and the new 254*U*. The shaft diameter and length will be larger on the 254*U* than on the old 254. A 10 hp, 1,800 rpm motor will be on the new 254*U* frame, but only 7½ hp, 1,800 rpm on the old 254. Because of this increase in horsepower on this frame diameter, the possibility of a motor on the new frame replacing the same diameter frame of the older design is remote, except where increased hp is required, and even then the differences in shaft size will present some problem in mounting.

Since, for a given horsepower and speed, the new frame will be smaller

Table II—Dimensions of Old and New Foot-mounted Motors*

(Single and Polyphase Squirrel Cage Machines)



Frame		Key			A	B	D	E	F	BA	H	N-W	U	V	AA
New	Old	Wdth.	Thick.	Lgth.	Max.	Max.								Min.	
182		3/16	3/16	1 3/8	9	6 1/2	4 1/2	3 3/4	2 1/4	2 3/4	11/32	2 1/4	7/8	2	3/4
	203	3/16	3/16	1 3/8	10	7 1/2	5	4	2 3/4	3 1/8	11/32	2 3/4	3/4	2	3/4
	204	3/16	3/16	1 3/8	10	8 1/2	5	4	3 1/4	3 1/8	11/32	2 3/4	3/4	2	3/4
184		3/16	3/16	1 3/8	9	7 1/2	4 1/2	3 3/4	2 3/4	2 3/4	11/32	2 1/4	7/8	2	3/4
	204	3/16	3/16	1 3/8	10	8 1/2	5	4	3 1/4	3 1/8	11/32	2 3/4	3/4	2	3/4
	224	1/4	1/4	2	11	8 3/4	5 1/2	4 1/2	3 3/8	3 1/2	11/32	3	1	2 3/4	3/4
213		1/4	1/4	2	10 1/2	7 1/2	5 1/4	4 1/4	2 3/4	3 1/2	11/32	3	1 1/8	2 3/4	3/4
	225	1/4	1/4	2	11	9 1/2	5 1/2	4 1/2	3 3/4	3 1/2	11/32	3	1	2 3/4	3/4
	254	1/4	1/4	2 3/8	12 1/2	10 3/4	6 1/4	5	4 1/8	4 1/4	11/32	3 3/8	1 1/8	3 1/8	1
215		1/4	1/4	2	10 1/2	9	5 1/4	4 1/4	3 1/2	3 1/2	11/32	3	1 1/8	2 3/4	3/4
	254	1/4	1/4	2 3/8	12 1/2	10 3/4	6 1/4	5	4 1/8	4 1/4	11/32	3 3/8	1 1/8	3 1/8	1
254U		3/16	3/16	2 3/4	12 1/2	10 3/4	6 1/4	5	4 1/8	4 1/4	11/32	3 3/4	1 1/8	3 1/2	1
	284	1/4	1/4	2 3/4	14	12 1/2	7	5 1/2	4 3/4	4 3/4	11/32	3 3/4	1 1/4	3 1/2	1
256U		3/16	3/16	2 3/4	12 1/2	12 1/2	6 1/4	5	5	4 1/4	11/32	3 3/4	1 1/8	3 1/2	1
	324	5/16	5/16	3 3/4	16	14	8	6 1/4	5 1/4	5 1/4	11/32	4 1/8	1 1/8	4 5/8	1 1/4
284U		3/16	3/16	3 3/4	14	12 1/2	7	5 1/2	4 3/4	4 3/4	11/32	4 7/8	1 5/8	4 5/8	1 1/4
	326	3/8	3/8	3 3/4	16	15 1/2	8	6 1/4	6	5 1/4	11/32	4 7/8	1 5/8	4 5/8	1 1/4
286U		3/8	3/8	3 3/4	14	14	7	5 1/2	5 1/2	4 3/4	11/32	4 7/8	1 5/8	4 5/8	1 1/4
	326	3/8	3/8	3 3/4	16	15 1/2	8	6 1/4	6	5 1/4	11/32	4 7/8	1 5/8	4 5/8	1 1/4
	364	1/2	1/2	4 1/4	18	15 1/4	9	7	5 5/8	5 7/8	11/32	5 5/8	1 7/8	5 3/8	1 1/2
	364S	3/8	3/8	1 7/8	18	15 1/4	9	7	5 5/8	5 7/8	11/32	3 1/4	1 1/8	3	1 1/2
324U		1/2	1/2	4 1/4	16	14	8	6 1/4	5 1/4	5 1/4	11/32	5 5/8	1 7/8	5 3/8	1 1/2
	364	1/2	1/2	4 1/4	18	15 1/4	9	7	5 5/8	5 7/8	11/32	5 5/8	1 7/8	5 3/8	1 1/2
	365	1/2	1/2	4 1/4	18	16 1/4	9	7	6 1/8	5 7/8	11/32	5 5/8	1 7/8	5 3/8	1 1/2
324S		3/8	3/8	1 7/8	16	14	8	6 1/4	5 1/4	5 1/4	11/32	3 1/4	1 1/8	3	1 1/2
	364S	3/8	3/8	1 7/8	18	15 1/4	9	7	5 5/8	5 7/8	11/32	3 1/4	1 1/8	3	1 1/2
326U		1/2	1/2	4 1/4	16	15 1/2	8	6 1/4	6	5 1/4	11/32	5 5/8	1 7/8	5 3/8	1 1/2
	365	1/2	1/2	4 1/4	18	16 1/4	9	7	6 1/8	5 7/8	11/32	5 5/8	1 7/8	5 3/8	1 1/2
	365S	3/8	3/8	1 7/8	18	16 1/4	9	7	6 1/8	5 7/8	11/32	3 1/4	1 1/8	3	1 1/2
326S		3/8	3/8	1 7/8	16	15 1/2	8	6 1/4	6	5 1/4	11/32	3 1/4	1 1/8	3	1 1/2
	365S	3/8	3/8	1 7/8	18	16 1/4	9	7	6 1/8	5 7/8	11/32	3 1/4	1 1/8	3	1 1/2

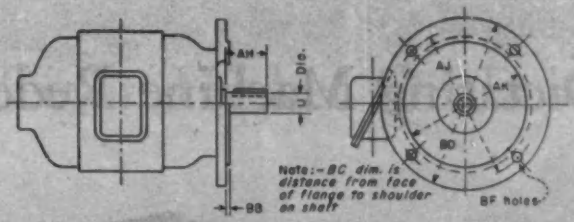
* All dimensions in inches.

than the old, mounting dimensions will not match and replacements of old by new will be a problem. Machinery manufacturers, who use motors as a part of their product, will probably revise their motors mounting brackets and bases, and the diameter of the bore of couplings and sheaves. Where motors on the new frames are to be used as replacements or spares for those on old frames, adapter bases, used with the new frame, will make for quick replacement of the old. Some motor manufacturers, and probably some base manufacturers, will have these adapter bases available. In an emergency, the motor user will probably make his own arrangements.

During the period of change over from old to new frames, it will be advisable for anyone who specifies, or purchases motors to know whether the motor will be on the new or old frame and to insist that he be furnished certified dimension prints.

Dimensions for D-flange motors have been approved for the new frames. In practically all cases of possible replacement of the old frame by the new in D-flange motors, di-

Table III—Dimensions of Old and New Flange Mounted Motors
(Single and Polyphase Squirrel Cage Machines)



Frame		AJ	AK	BD Max.	AH	BC*	BB Max.	U	Key		BF	
New	Old								Width	Thick	Size	No.
182D		10	9	11	2¼	0	1/4	7/8	1/4	1/4	11	4
	203D*	10	9	11	2¼	0	1/4	3/4	1/4	1/4	11	4
	204D	10	9	11	2¼	0	1/4	3/4	3/16	3/16	11	4
184D		10	9	11	2¼	0	1/4	7/8	1/4	1/4	11	4
	204D	10	9	11	2¼	0	1/4	3/4	3/16	3/16	11	4
	224D	10	9	11	3	0	1/4	1	1/4	1/4	11	4
213D		10	9	11	3	0	1/4	1 1/8	1/4	1/4	11	4
	225D	10	9	11	3	0	1/4	1	1/4	1/4	11	4
	254D	10	9	11	3 3/8	0	1/4	1 1/8	1/4	1/4	11	4
215D		10	9	11	3	0	1/4	1 1/8	1/4	1/4	11	4
	254D	10	9	11	3 3/8	0	1/4	1 1/8	1/4	1/4	11	4
254UD		12½	11	14	3¾	0	1/4	1 3/8	3/16	3/16	11	4
	284D	12½	11	14	3¾	0	1/4	1¼	1/4	1/4	11	4
256UD		12½	11	14	3¾	0	1/4	1 3/8	3/16	3/16	11	4
	324D	12½	11	14	4 7/8	0	1/4	1 5/8	3/8	3/8	11	4
284UD		12½	11	14	4 7/8	0	1/4	1 5/8	3/8	3/8	11	4
	326D	12½	11	14	4 7/8	0	1/4	1 5/8	3/8	3/8	11	4
286UD		12½	11	14	4 7/8	0	1/4	1 5/8	3/8	3/8	11	4
	326D	12½	11	14	4 7/8	0	1/4	1 5/8	3/8	3/8	11	4
	364D	16	14	18	5 5/8	0	1/4	1 7/8	1/2	1/2	11	4
	364SD	16	14	18	3¼	0	1/4	1 5/8	3/8	3/8	11	4
324UD		16	14	18	5 5/8	0	1/4	1 7/8	1/2	1/2	11	4
	364D	16	14	18	5 5/8	0	1/4	1 7/8	1/2	1/2	11	4
	365D	16	14	18	5 5/8	0	1/4	1 7/8	1/2	1/2	11	4
324SD		16	14	18	3¼	0	1/4	1 5/8	3/8	3/8	11	4
	365SD	16	14	18	3¼	0	1/4	1 5/8	3/8	3/8	11	4
326UD		16	14	18	5 5/8	0	1/4	1 7/8	1/2	1/2	11	4
	365D	16	14	18	5 5/8	0	1/4	1 7/8	1/2	1/2	11	4
	365SD	16	14	18	3¼	0	1/4	1 5/8	3/8	3/8	11	4
326SD		16	14	18	3¼	0	1/4	1 5/8	3/8	3/8	11	4
	365SD	16	14	18	3¼	0	1/4	1 5/8	3/8	3/8	11	4

Note 1: Dimensions suitable for vertical motors—Add suffix letter V to frame.

mensions of the flange itself have remained unchanged. Key and shaft size have changed for about one-half of the comparisons listed in the tabulations.

Dimensions of *P*-flanges for vertical motors and of *C*-face mounted integral horsepower motors in the new frames were not approved when this was written.

Availability

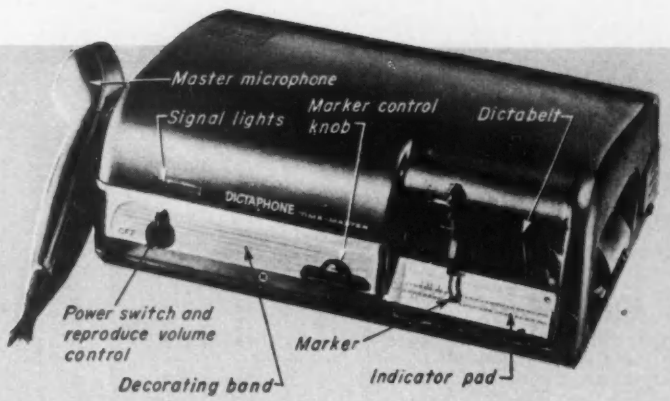
It is estimated that motors built on the new frames will be available generally as follows:

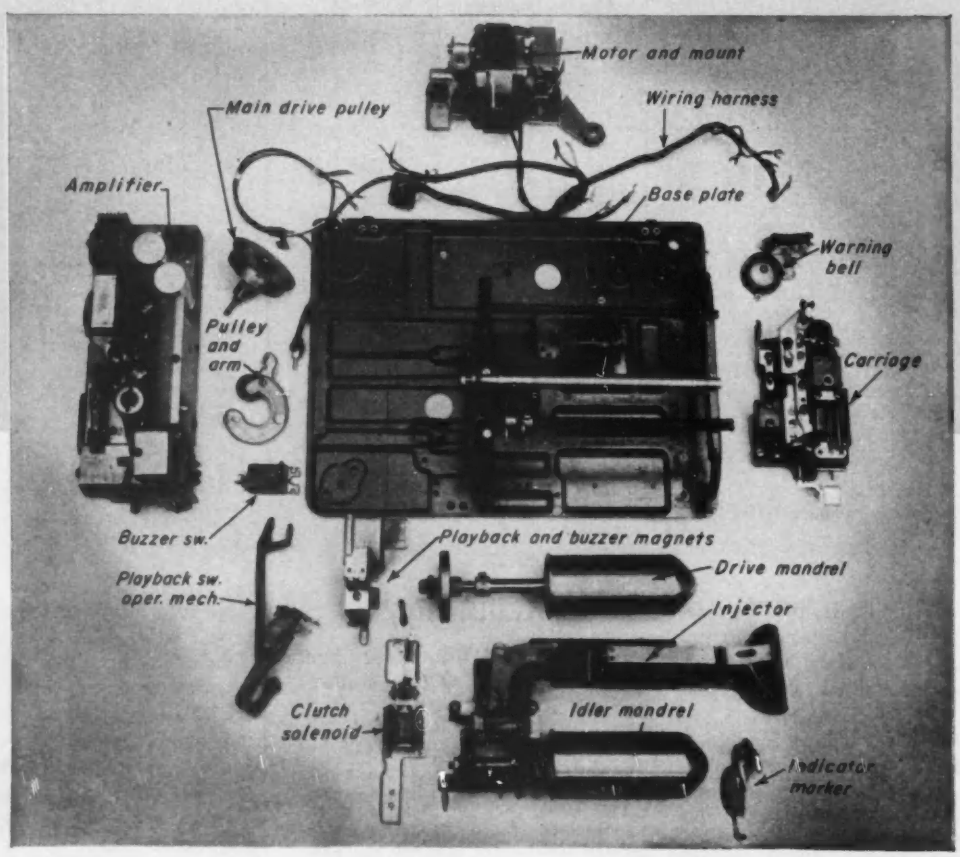
FRAME	*DATE*
182–184	Jan. 1, 1954
213–215	June 1, 1954
254U–256U	Nov. 1, 1954
284U–286U	April 1, 1955
324U–326U	Nov. 1, 1955

How long motors on the old frames size will be available depends on the individual motor manufacturer — on how many completed motors and what stock of component parts he has on hand—when he makes the change. However, most manufacturers will probably arrange so that spare or replacement parts will be available for some years to come.

Dictating Machine Redesigned for

WEIGHING less than 13 lb including microphone and attaching cables, the new Time-Master features a redesigned monitoring system to indicate letter length and correction positions. Other improvements include a special signal light that flickers when the proper recording volume is reached. The cover has been restyled to give a more streamlined appearance to blend in with other desk-positioned appointments.





IN NEW PRODUCTS

Lower Weight, Higher Quality

The new Time-Master dictating machine, latest in Dictaphone Corporation's Time-Master series first introduced in 1948, stresses the growing trend in the redesign of an existing product: improving overall performance within current price levels. Increased costs resulting from adding new features are offset by changes made in materials and production techniques that cost less. Net result obtained is a functionally styled unit capable of high quality recording in the range from 100 to 5,000 cycles, and weighing only 12 lb, 8 oz—more than 3 lb lighter than last year's model; about 9 lb less than the 1948 machine.

One of the most important changes is the arrangement used to indicate length of letters and points of correction. The older design was based on the moving of a silver disk against abrasive paper. To overcome the wear of the disk and to improve the visibility of the mark, a new indicating pad was developed. Made up of a basic stock of bright red coating and then covered with a thin layer of white lacquer, the surface is scratched by a stylus exposing the brilliant background and giving a vivid contrast to indicate a monitoring position. In conjunction with the new paper, the control knob actuating the stylus is placed in a stationary position, the linkage transmitting the movement of the knob being designed to insure a uniform pressure at the stylus for smooth scratching of the paper.

Another improvement is the use of highly viscous silicone oils as a damping means for the movement of the recorder and reproducer heads.

One change resulting in an improved product at a lower cost is the new belt for transmitting the motor drive. Made of a nylon rubber impregnated fabric, the belt has negligible stretch, uniform flexibility and a high coefficient of friction.

Weight reduction was obtained by changing many parts from steel to anodized and Martin hard-coated aluminum and some from aluminum to magnesium. Increased material costs were compensated by redesigning the parts for greater machining ease. Mountings of several components were changed to simpler methods of equal effectiveness. And the number of sub-assemblies was increased to permit more complete control over product quality.

←

GREATER NUMBER of sub-assemblies in redesigned model offset increased costs. Besides reducing labor costs, increasing the sub-assemblies improves testing and final inspection.

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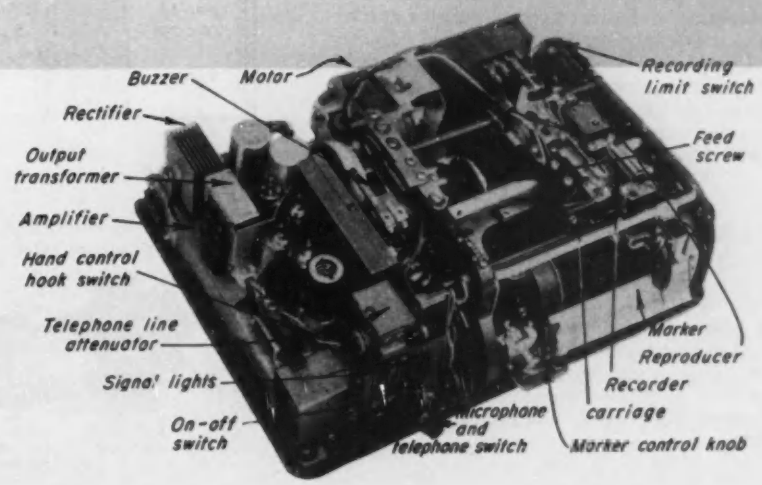
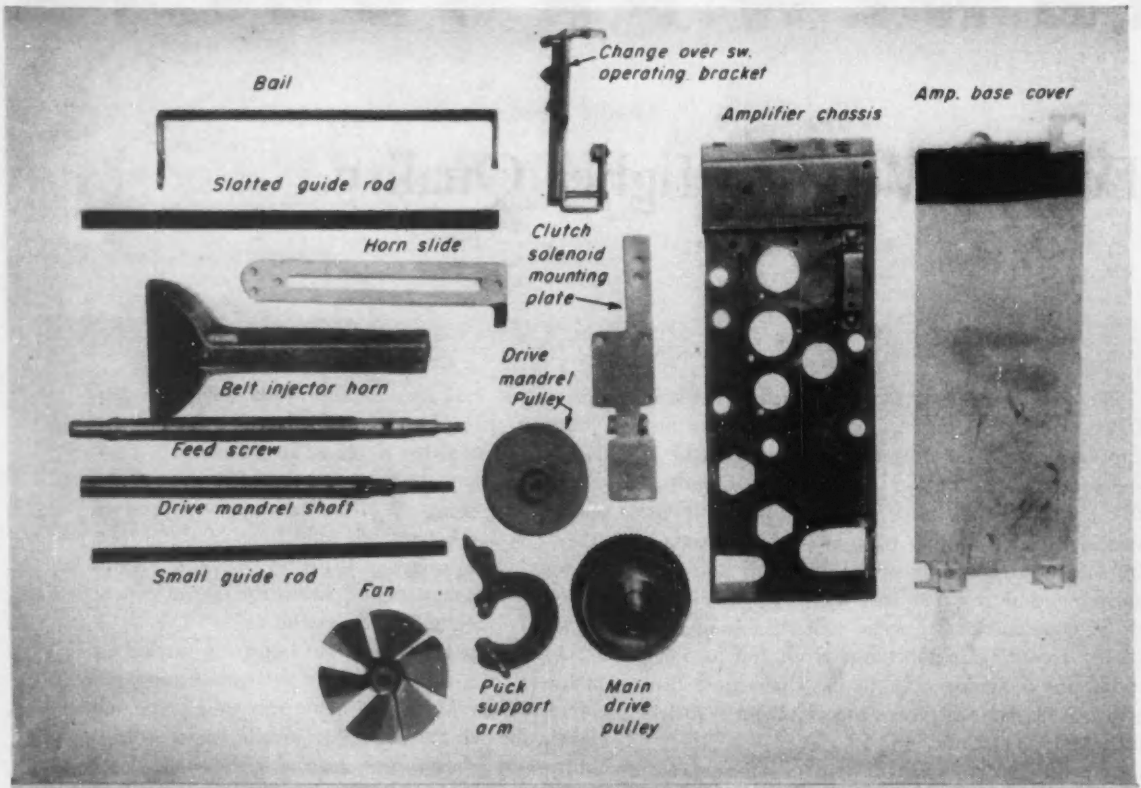
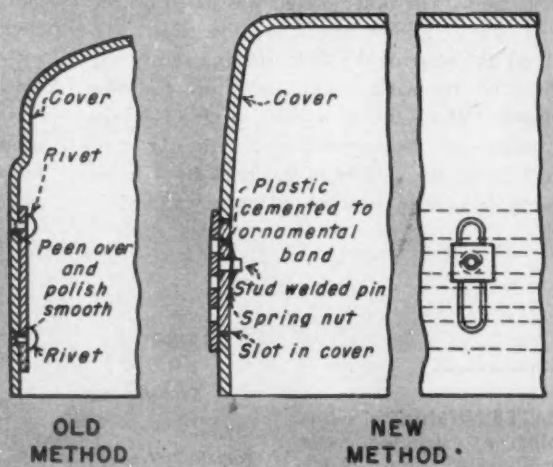
COMPACT UNIT contains the necessary components for operation on a-c or d-c current, or under varying voltage and cycle conditions. Some models are equipped for telephone dictation.



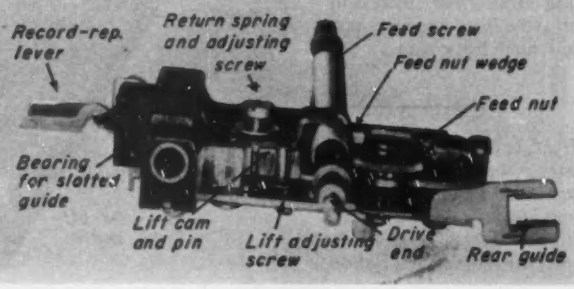


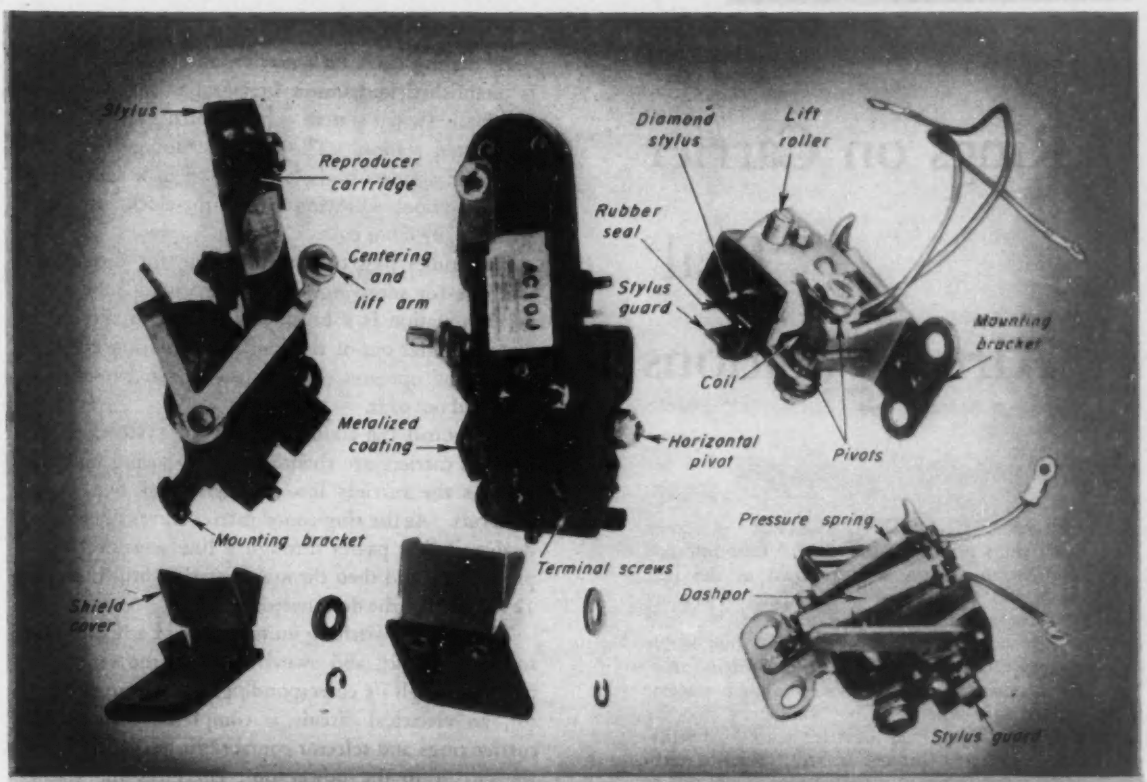
(ABOVE) Weight reduction achieved in new model is approximately 3 pounds. Components at left were changed from steel to aluminum and then anodized. Those on right were changed from aluminum to magnesium. Other weight savings were realized by redesigning to eliminate excess metal.

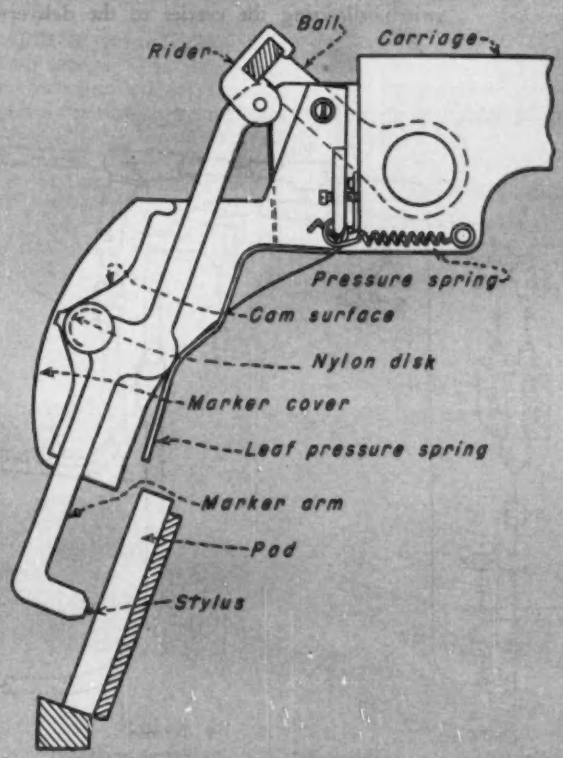
(RIGHT ABOVE) Improved method for attaching ventilating screen and horizontal ornamental band. Former method consisted of riveting screen to cover, then peening and polishing before finishing. New procedure entails welding a series of studs to the strip and cementing over the studs oval-shaped pieces of plastic matching the slot shapes punched out of the cover. Strip is secured by Speed nuts.



(RIGHT BELOW) Cutaway of carriage drive mechanism. A circular nut is locked in engagement with the feed screw to move the carriage. The constantly engaged feed screw and nut permit use of a 32 pitch screw. If a fixed nut had to be used for engaging and disengaging, a 200 pitch screw, matching the spacing of the grooves on the belt, would be required to insure backspacing of one groove at a time.







(ABOVE) Recorder and reproducer heads. Recording is done by embossing plastic belt with conical-end stylus. Critical 0.005 in. spacing between embossed groove centers is maintained by weight of recorder and calibrated spring pressure. Reproducer offset 2-3 grooves to left of recorder has its stylus in constant engagement with grooves. Play back is obtained by electrically switching from one unit to the other. Viscous silicone oil in recorder dashpot controls lowering rate of recorder head; in reproducer's lateral and vertical cone-type pivots prevents vibration or rapid fluctuations of stylus following grooves during playback.

(LEFT) Operation of the monitor. Movement of the control knob clockwise or counterclockwise is transmitted through a linkage to a bail or rod extending across the front of the machine. A rider moving with the carriage and attached to the marker arm is fitted over the rod and pivots corresponding to the rotation of the control knob to raise or lower the arm. A nylon disk mounted on the arm and held in contact with an internally cast cam contour in the marker cover rides up on the cam forcing the marker stylus against the indicating pad.

Rings on Carrier "Dial" Airtube Stations

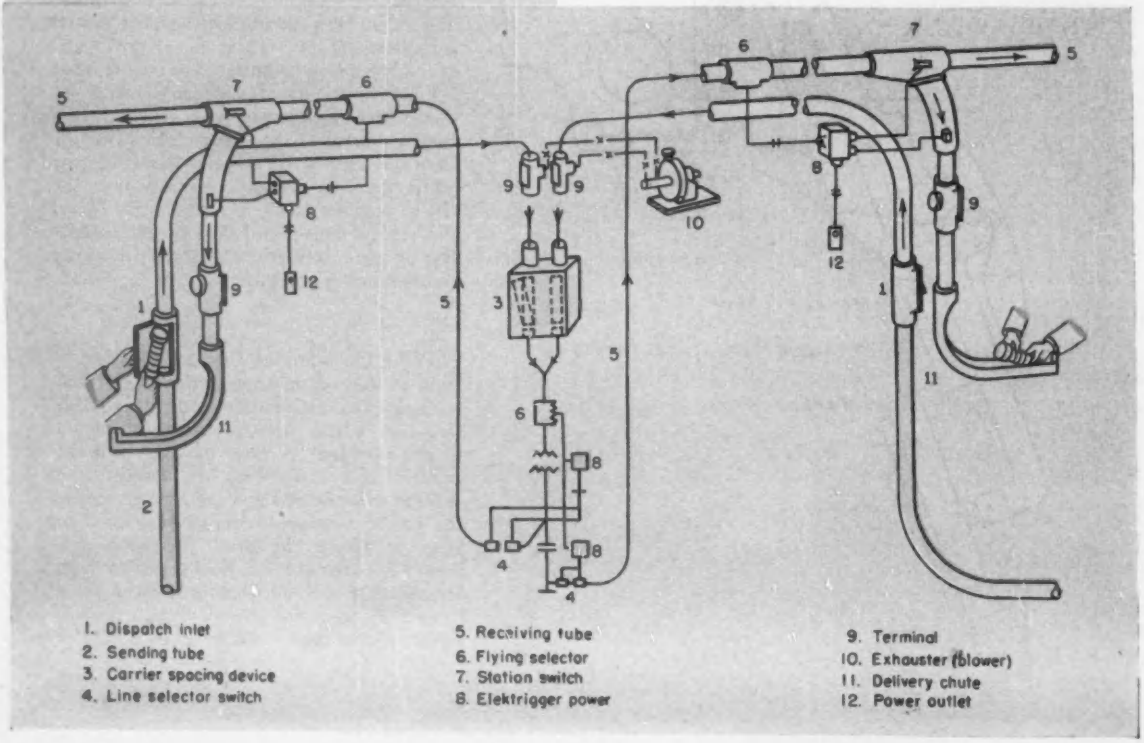
By dialing rings on a carrier, an electrical memory is established in Lamson Corporation's new Airtube automatic switch system carrier which guides it to its designated station. The main advantage over conventional systems is the elimination of a central dispatch station, allowing round-the-clock operation without any labor cost.

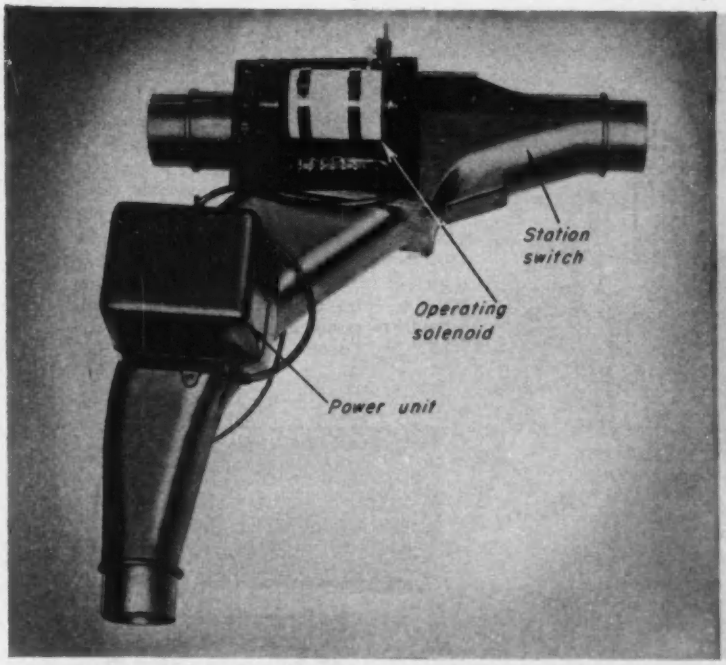
Two tubes pass each station, one for dispatching and one for receiving. In the receiving tube ahead of each station is a brush selector which directs the proper carrier out of the line. Each station is locally wired, and operates only for the carrier preset to be switched out of it.

To control the traffic through the system, all dispatched carriers are channeled to a spacing unit that releases the carriers into the system at five second intervals. As the ring-coded carrier leaves the spacing device, it first passes through a line selector for the proper line and then through a station brush selector 12 ft ahead of the designated terminal.

The station switching units consist of a brush selector, power unit, and switch. When the set carrier passes through its correspondingly coded brush selector, an electrical circuit is completed through the carrier rings and selector contact brushes. Closing of the circuit to the power unit energizes the station switch, directing the carrier to the delivery chute.

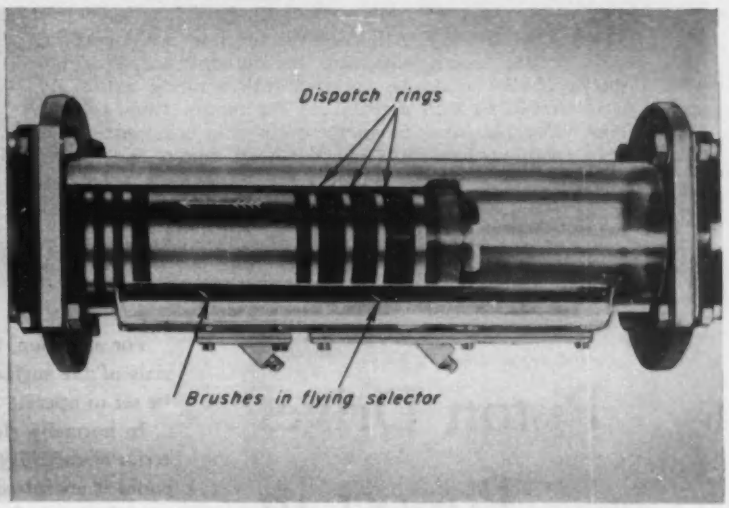
SCHEMATIC OF THE SYSTEM. A carrier with rings preset for the desired tube line and destination station is dispatched at the left, as shown. Carriers similarly dispatched at other stations are all channeled to a spacing unit which spaces the carriers into the system at five second intervals. On entering the spacing unit, the alphabetical ring activates a brush selector in the unit which switches the carrier into the proper tube line. As a carrier nears its destination, it passes through a brush selector electrically connected to a station switch and power unit. At this point, the station switch channels the carrier into the delivery chute.

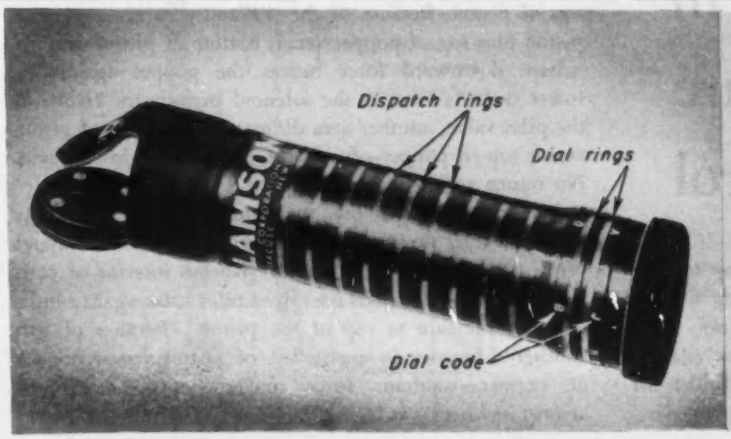




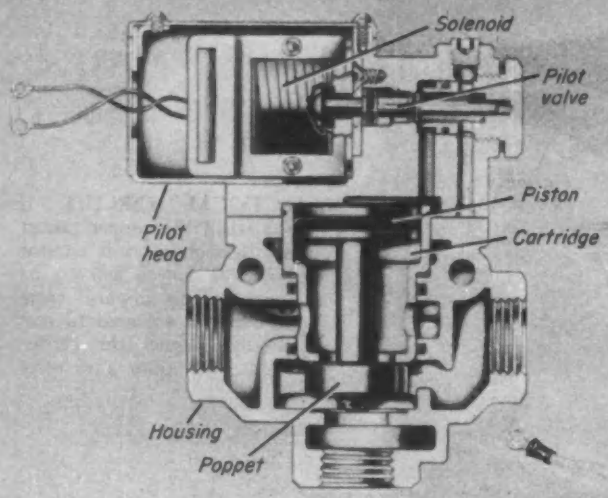
ELECTRICAL CIRCUIT is closed when the proper carrier passes through a brush selector causing the power unit to be energized. This impulse energizes a power solenoid to mechanically channel the carrier from the tube into a delivery chute.

CARRIER passing through a brush selector. As the carrier approaches its designated station, dispatch rings on the carrier complete an electrical circuit through the brushes in the brush selector. The electrical impulse that results then energizes a power unit to actuate a carrier switching solenoid which switches the carrier to its destination.

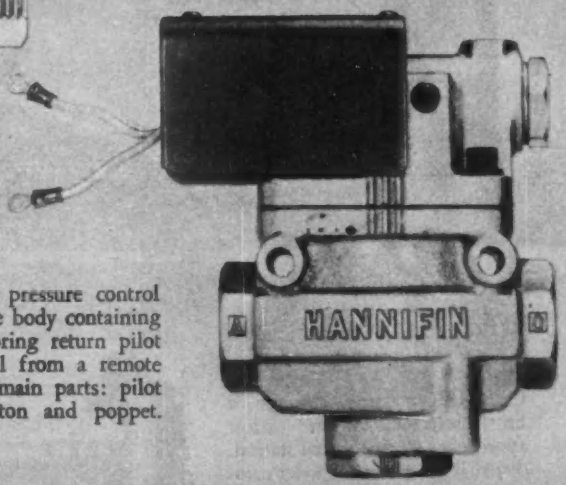




CARRIER has dial rings at one end for selecting the desired designation point. Up to 100 stations, the alphabetical code selects the tube; the numerical code, the station. Setting of the dial rings establishes electrical contacts within the carrier between the various dispatch rings. This setting then corresponds to the permanent setting of the contact brushes in the selector.



CUTAWAY SHOWS ESSENTIAL SIMPLICITY of valve design. The housing is a bronze casting with no moving parts. Main valve mechanism consists of a "piston-poppet" assembly which fits in a removable cartridge. The pilot head contains a miniature poppet-type valve—the poppet is integral with the valve stem—actuated by a short-stroke, low-amperage solenoid. The pilot valve gets its pressure from the main valve and exhausts through passages not shown in this view.



THIS THREE-WAY AIR VALVE for low pressure control has a pressure return pilot head. But the same body containing the main valve could be equipped with a spring return pilot head instead or with a plain cap for control from a remote pilot valve. In basic design there are three main parts: pilot head, housing and cartridge containing piston and poppet.

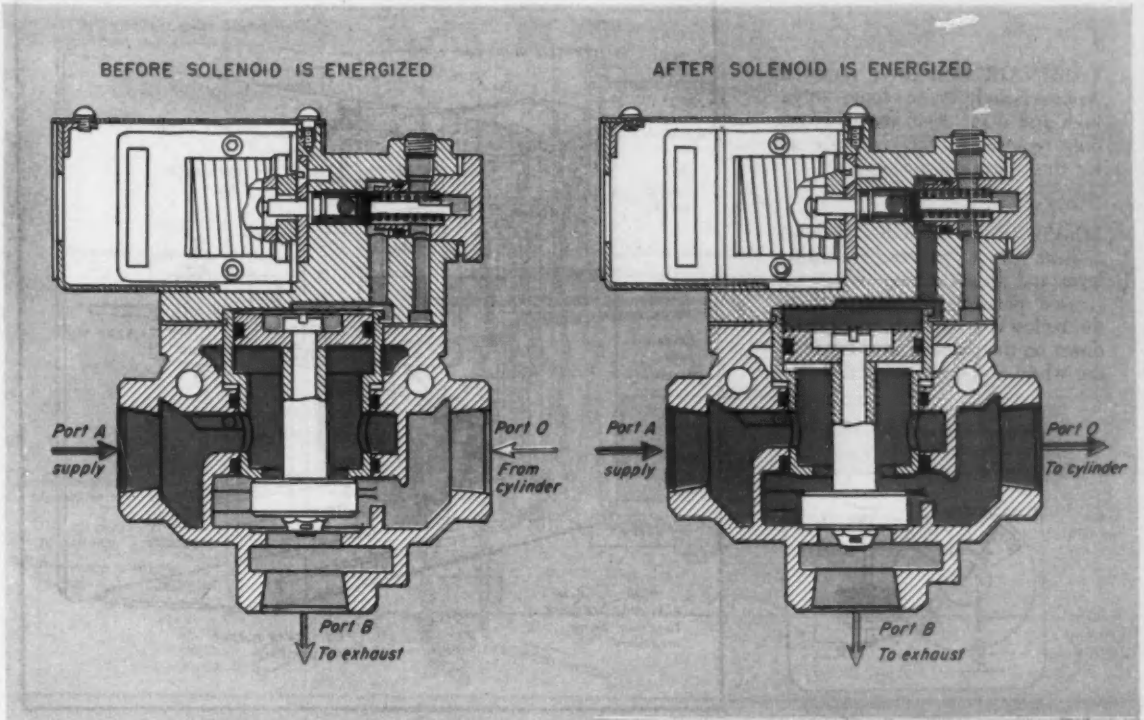
Piston Drives Poppet in Low Pressure Air Control

Assembled in a brass cartridge for easy replacement, a piston-actuated poppet directs air flow in the Hannifin Corporation's 3-way and 4-way Pilot Master valves for low pressure control circuits. In addition, the cartridge serves as a cylinder for the piston and an upper valve seat for the poppet.

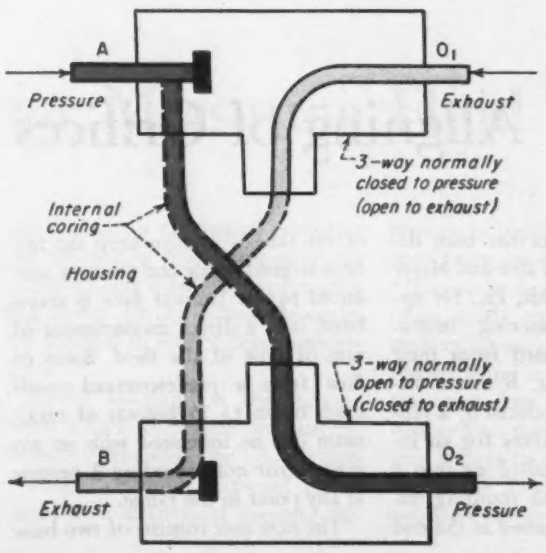
For actuation, the main valve depends on area differentials of the surfaces to which pressure is applied. It may be set to operate either normally open or normally closed.

In normally closed operation, inlet pressure reaches interior of cartridge and outlet is open to exhaust. When solenoid is energized, pilot valve admits inlet air pressure to top of piston. Because of the difference in areas—top of piston plus top of poppet versus bottom of piston—the resultant downward force moves the poppet against its lower seat. As soon as the solenoid permits the return of the pilot valve, another area differential—bottom of piston versus top of poppet—forces the main valve closed again. No return spring is needed.

For normally open use, the bottom port is the supply port, and inlet pressure keeps the poppet against its upper vent. Only atmospheric pressure reaches interior of cartridge. When solenoid is energized pilot valve again admits inlet air pressure to top of the piston. Because of still another difference in areas—top of piston versus bottom of poppet—resultant force moves poppet downward against its lower seat.



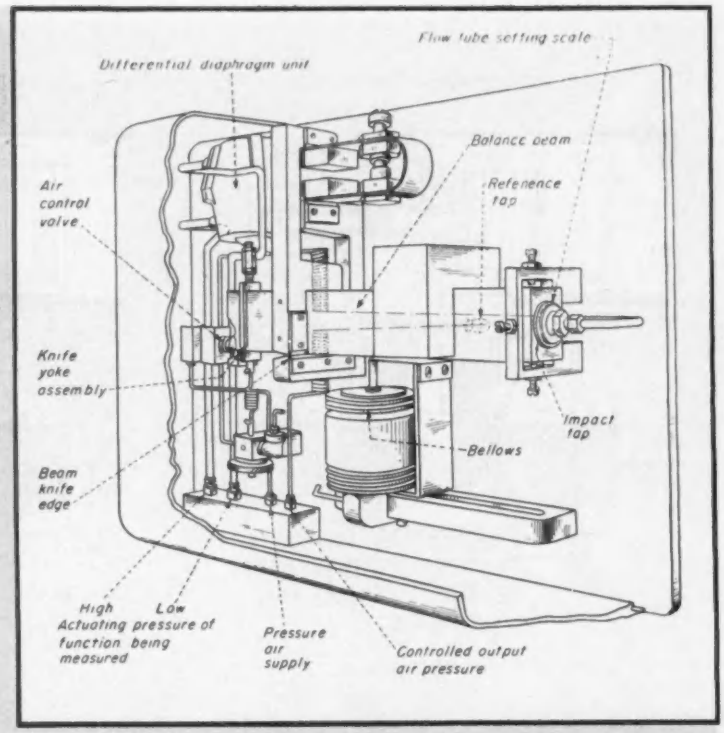
NORMALLY CLOSED VALVE is shown before and after solenoid is energized. Area differential between bottom of piston and top of poppet acts to hold valve closed (left). Energizing solenoid (right) causes pilot valve to admit pressure to top of piston. Area differential now has a downward resultant so valve opens.

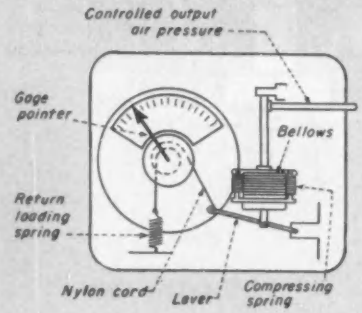


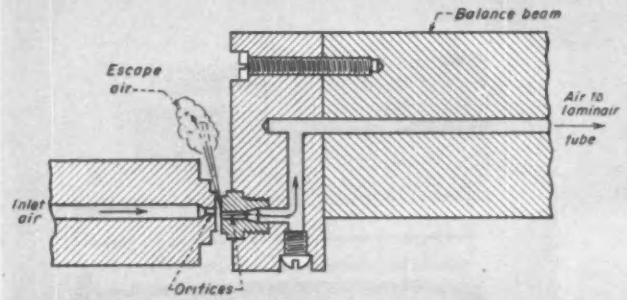
SAME BASIC DESIGN appears in both 3-way and 4-way valves. Schematic (left) shows how two 3-way valves—one normally open, one normally closed—go together in a common housing with internal coring so arranged as to form a 4-way valve. Pictured above is a complete 4-way valve and a spring return pilot head. Note outlet designations on casting.

LAMINAIR with cover removed. Approximately 24 in. long, 20 in. high and 6 in. deep, the new unit only requires 0.1 cfm of free air for the controlled air supply.

MEASURING GAGE (below) consists of a bellows, indicating lever and scale pointer. When increased pressure is transmitted to the bellows, it expands and pushes down on the pivoted lever to rotate the wheel and scale pointer.







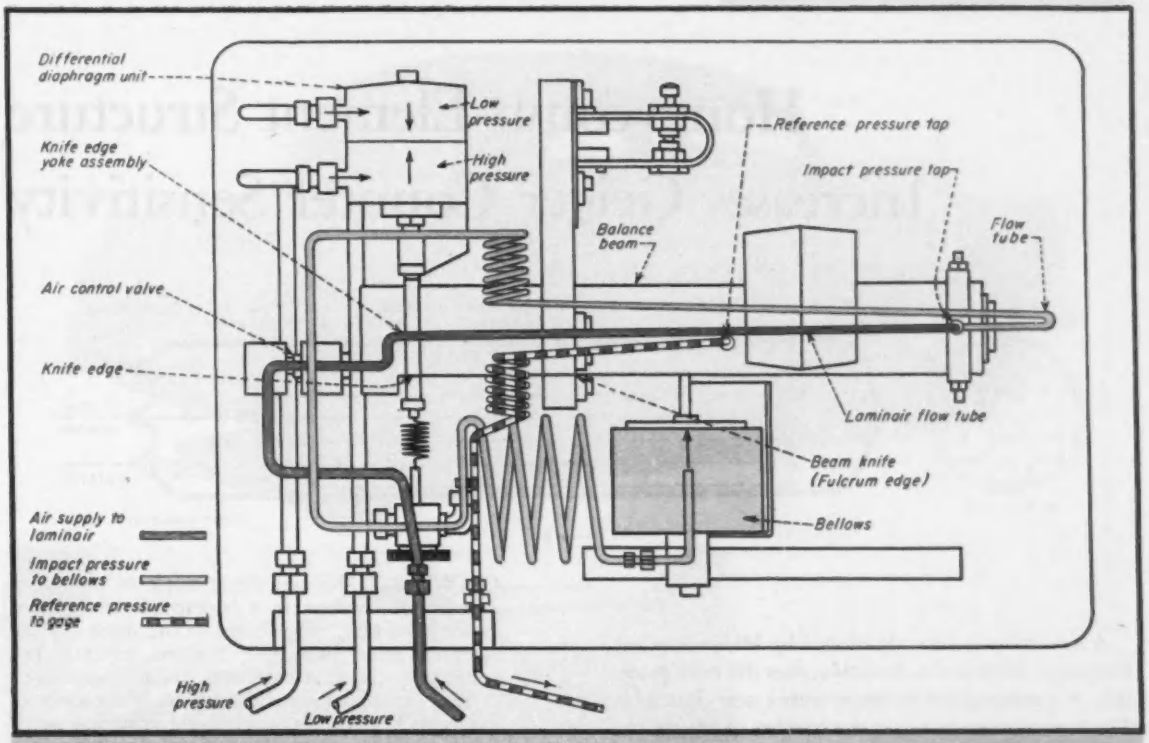
AIR VALVE consisting of two orifices controls the amount of controlled air admitted into the flow tube in the balance beam. During no-flow, the beam is down and the orifices are out of alignment permitting the inlet air to escape. As flow increases, the balance beam moves upward (by action of the diaphragm element) and the orifices are aligned directing the inlet air into the flow tube.

Since the differential fluid pressure varies as the square of the measured fluid flow, and the impact air pressure varies as the square of the air flow along the tube, the forces relating to flow are continuously and directly balanced. And since the reference orifice pressure taken from the side of the flow tube varies directly as the velocity of air flow along the tube and thus as the flow of measured fluid, a varying air pressure of linear characteristics is obtained to actuate the measuring instrument.

Aligning of Orifices

A pneumatic device has been developed by Simplex Valve and Meter Company, Philadelphia, Pa., for application with measuring instruments distantly located from their primary sensing units. It uses a differential pressure produced by a venturi to align two orifices for an increase flow of controlled air into a special flow tube. The resulting impact air pressure obtained at the end of the tube is used to keep the orifices aligned while the pressure produced by the laminar flow is translated into a direct measurement of rate of flow of the fluid. Rates of flow from a predetermined maximum down to 15 percent of maximum can be measured with an average error not exceeding 3 percent at any point in the range.

The new unit consists of two basic



HOW DIFFERENTIAL CONVERTER WORKS. High and low fluid pressure lines are connected to a differential diaphragm device. Dependent upon flow through a venturi, a pressure difference is created in the bellows within the diaphragm unit pushing the diaphragm upwards and moving the balance beam clockwise about its fulcrum. As the beam moves upwards, the two orifices in the air control valve become closer aligned permitting an increased flow of controlled air into the flow tube in the beam. Increased air flow results in an increase in impact pressure at the end of the tube, the pressure being transferred to the bellows under the beam. Expansion of the bellows supplies an upward thrust on the beam balancing the pressure on the other end of the beam caused by the loading of the diaphragm. A reference pressure varying directly with the velocity of air passing through the flow tube is then led directly to the measuring instrument.

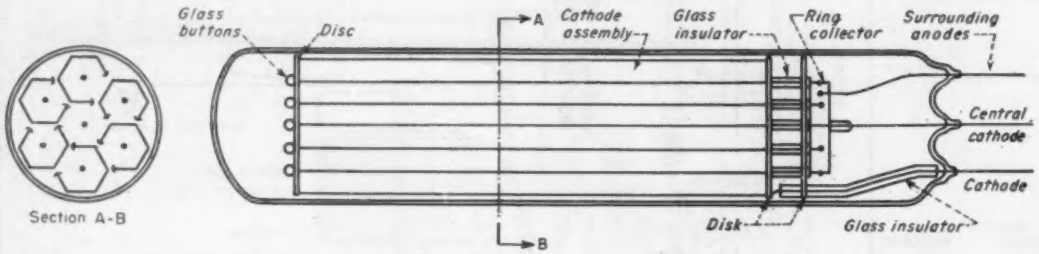
for Measuring Fluid Flow

mechanisms: a differential converter for translating fluid pressure to air pressure, and a bellows-type receiving device for converting the outlet air pressure to rate of flow measurement.

Initial loading on the balance beam is obtained by the pressure difference produced by fluid flow through a venturi. Upward movement of a differential pressure diaphragm unit pulls one end of a balance beam up causing the beam to tilt about its fulcrum. Raising of the beam tends to align two orifices making up an air control valve, the orifices being in perfect alignment at maximum flow. Inlet air flows from one orifice through the other and into a flow tube within the balance beam. The flow of air into the tube produces two pressures: Impact pressure at the end of the tube which is used to counterbalance the diaphragm loading on the balance beam, and a flow pressure of the air along the tube which is used for actuating the measuring device.

The Laminair is self-compensating. It can operate not only with a primary device producing a given maximum differential, but also on substantially different values.

Honeycomb Element Structure Increases Geiger Counter Sensitivity

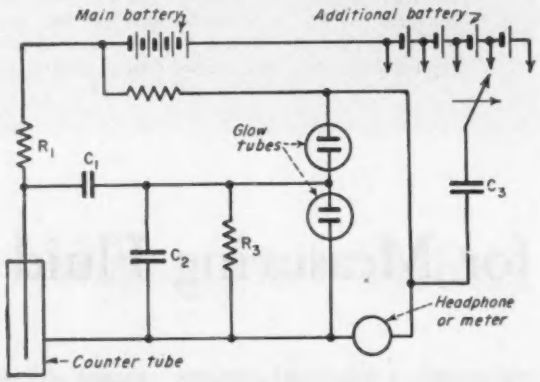


COUNTER TUBE uses the principle of connecting a group of counters in a honeycomb arrangement in one glass tube, the cathodes of the single counter elements being hexagonal in cross section. The assembly is closed at both ends by disks, each with 7 holes for supporting anode wires. Wires are kept in positon by glass insulators. Right hand disk serves as an electrical screen to prevent discharge between anode leads and cathode body. Anode wires are welded to a metal ring, but central wire can be separated from the 6 others to use the central counter element separately when strong radiation is present or for exact counting.

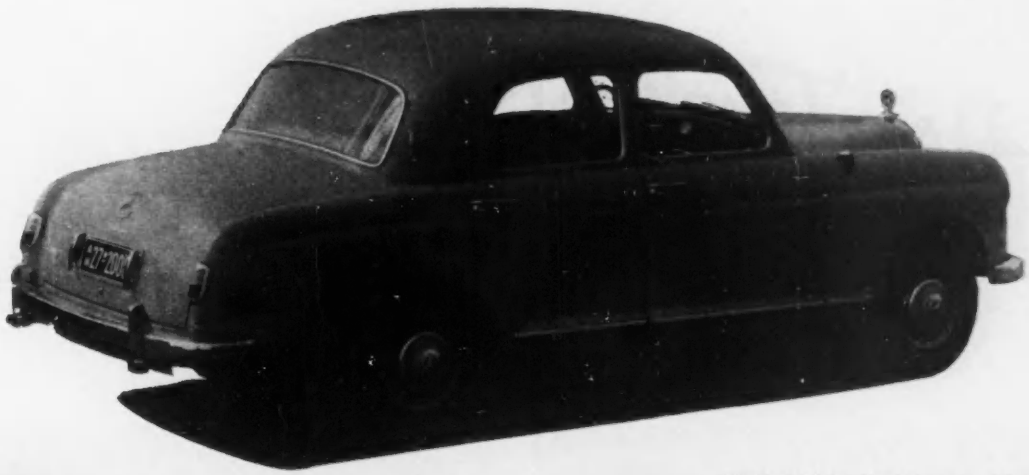
A new counter tube, developed by Muller Nuclear Industries, Melbourne, Australia, uses the basic principle of a manifold of counters within one glass tube. The new counter increases the number of counts per minute of gamma radiation and relatively reduces the cosmic radiation background count.

The cathodes of the single counter elements, which are hexagonal in cross section, are arranged so that the center element is surrounded by six others in a complete honeycomb. This results in a sensitivity about seven times that of a conventional single element unit. Also, since the cosmic ray background is only recorded according to the cross section that the counter elements present to the radiation, the relationship between useful radiation and background is improved by a factor greater than 2. A single counter element has a background count of 50 to 60 per minute; the new unit increases the sensitivity to a count of 150 to 180. This increase in sensitivity makes it easier to detect the presence of gamma rays, indicated by an increase over the background count.

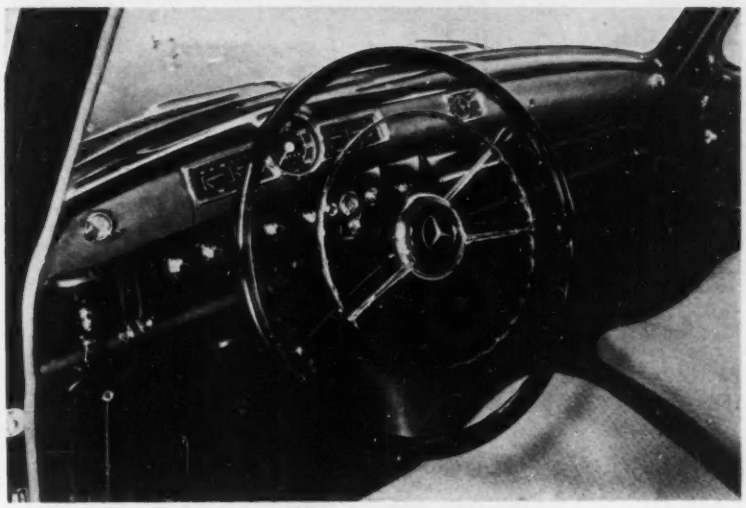
The new Muller-Geiger Counter is three feet long and two inches in diameter, and contains the counter tube, amplifier and batteries. For special applications, a number of counter tubes are arranged symmetrically. In one assembly, consisting of 49 elements, seven tubes are arranged in a complete honeycomb. This unit responds to a background radiation with about 500 counts per minute. Tests have shown that a gamma radiation, which has the same intensity as the background when measured by the older single element counter, yields over 2,500 counts per minute with the new assembly. This high counting speed permits a rapid survey for detecting radioactive materials, allowing use in fast-moving cars or airplanes.



ELECTRICAL DIAGRAM of the counter. Amplifier essentially consists of two glow discharge tubes in series; the counter impulses are transmitted to them through capacitor C. Series resistor R_2 and capacitor C_3 act to suppress the discharge for the next impulse: a high value resistor R_3 keeps the voltage across the glow tubes under the spark potential, allowing a small negative impulse from C_1 to ignite the tubes. Capacitor C_2, as well as R_3, acts to increase the tube sensitivity. To overcome any time lag in the firing of the glow tubes, the lower unit is painted with a small amount of radioactive material.



FROM THE REAR, new Mercedes Benz 180 could pass for an American car. Note deck-like luggage compartment, built in flap protecting the fuel tank fill tube, and the finned fenders. Car shuns features such as power steering, power brakes, automatic windows, and automatic seat adjustments.



ON THE INTERIOR, Mercedes also has a familiar look. There is a two spoke steering wheel with chrome horn ring, gear shift lever mounted on the steering wheel, leather dressing up the dashboard and interior, and one piece windshield—all traditional styling features found on many U. S. cars.

Mercedes Benz Goes American

Frankfurt—**Borrowing a leaf from American stylists, Daimler Benzwerke, Stuttgart, Germany, have designed the new Mercedes Benz to satisfy motorists' desire for a big, attractive automobile. This confirms a significant trend in European design: low- and medium-priced producers are shelving the traditional emphasis on high economy performance and are trying to imitate the spaciousness of American designs. Daimler is the second major European manufacturer to take the plunge; previously, Morris had developed a six-passenger, relatively, low-priced vehicle for American markets** ***(Product Engineering,*** **July 1953, pp 162-163).**

Bigness has meant sacrifices. Even though engine rating has been stepped up to 52 hp—high for this type of European car but exceedingly low according to American standards—gas mileage has dropped to 27 miles per gallon. Other European makes claim fuel consumption as low as 60 miles per gallon. Still the four cylinder 6.7:1 compression ratio engine can drive the Mercedes at a top speed of 78 miles per hour.

Expected price of this car is about 9,000 Deutche Marks, or just over $2,000. There are a limited number of accessories available. The transmission is manually shifted—a four speed, one reverse, gear box.

How Tough Are Nickel and Chromium

Table I—Mechanical Properties of Five Aircraft Alloys

Alloy	Density (gr/cm³)	Ultimate Tensile Strength (psi)	Yield Strength (psi)	Elongation (%)
Al 24S-T3	2.77	70,000	50,000	18
Al 75S-T6	2.81	80,000	70,000	12
Stainless Steel 321 (annealed)	8.1	90,000	40,000	60
SAE 4130 (normalized)	7.9	100,000	75,000	25
Titanium (commercially pure)	4.5	90,000	80,000	20

Table II—Nickel Plating Solutions

	Hard Nickel	Grey Nickel	Pinner Nickel	Bright Nickel
Nickel Sulfate oz/gal	24	....	26	40
Nickel Chloride oz/gal	3.3	40	23	8
Boric Acid oz/gal	4	4	5.3	5
Additives	....	....	....	*
Temperature, F	130	140	115	140
pH	5.6	2.0	20	4.5
Current, ASF	432	432	432	144

* Proprietary make-up instructions.

Table III—Chromium Plating Solutions

	Hard Chromium	Low Contraction Chromium	Low Fatigue Chromium
Chromic Acid oz/gal	33	6.7	80
Sulfate Ratio	100/1	100/1	190/1
Temperature, F	131	185	85
Current, ASF	432	432	576

HENRY PAIGE,* LT. J. H. JAMES**
F. S. WILLIAMS***

* *Supervisor, Surface Treatment & Corrosion Section, Metallurgical Division, Naval Air Experimental Station, Philadelphia*
** *Airborne Equipment Division, Bureau of Aeronautics*
*** *Head, Metallurgical Division, Naval Air Experimental Station, Philadelphia*

As a means of increasing the application scope of high strength aluminum alloys, electroplating techniques are attracting considerable attention. The basic considerations involved in their use are the selection of plates, application thickness, and surface pretreatment: Which offer the best resistance to corrosion? . . . Which are best in retention of mechanical strength properties?

Among the promising electroplates for aluminum are nickel and chromium. As hard surface deposits, they permit the application of aluminum alloys where weight reduction, without sacrifice in strength or wear resistance, is necessary to design. High strength aluminum alloys of the dural and zinc bearing types, when heat-treated, for example, approach the strength of some alloy steels, and possess much lower densities, Table I.

The value of nickel and chromium electroplated high strength aluminum has been revealed in a series of corrosion and mechanical strength studies conducted by the U.S. Navy Bureau of Aeronautics. One phase of this testing program was conducted on standard .505 in. round bars, from which the data presented in this article have been obtained. The bars, fabricated from Al 24S-T4 and Al 75S-T6, were plated with several types and thicknesses of nickel and chromium deposits, ranging in thickness from 1 to 8 mils, and a combination duplex chromium nickel deposit, prepared with 2-mil hard chromium over 2-mil bright nickel. The nickel deposits, Table II, were: Hard nickel, Grey nickel, Pinner nickel, and Bright nickel. The bath composition included both a propietory Watt's and a high chloride type. The chromium deposits, Table III, were: Hard chromium, Low contraction chromium, and Low fatigue chromium.

(The data presented in this article are those of the authors and are not to be construed as official data released by the Department of the Navy).

Electroplates for Aluminum?

Table IV—Plating Procedures

(Rinse follows each step; D & E are repeated before copper strike)

Step	Composition	Potential	Temperature, F	Time
A—Degreasing				
B—Alkaline Cleaning	(1) Oakite #90, 4 oz/gal or		180	5 sec
	(2) 3 % sodium carbonate +3 % trisodium phosphate		175	3 min
C—Acid Cleaning	(1) Chromic Acid, 35g/1, +Sulphuric Acid, 175g/1, or		180	5 min
	(2) 25 % (wt.) Sulfuric Acid		175	3 min
D—Acid Dip	Nitric Acid 1:1		70	30 sec
E—Zinc Immersion	Zinc Oxide 100g/1 + Sodium Hydroxide 525g/1		70	1 min
F—Copper Strike	Rochelle bath, low free cyanide	Applied before immersion; preset to 100 ASF, reduced to 20 ASF after 3–5 sec	100	10 min
H—Acid Dip	5 % Sulfuric Acid			5 sec
I—Plate	(1) Bright Nickel	144 ASF	140	
	(2) Hard Chromium	432 ASF	131	

PLATING PROCEDURES

Depending upon test conditions and electroplate employed, surface pretreatment prior to plate application varied basically from a zinc immersion-copper strike process, designed to induce maximum uniform adhesion.

The nickel plated specimens, for example, were prepared with this process, Table IV. The specimens were first alkaline cleaned and acid pickled to deoxidize the surface, and the zinc film was deposited chemically from a sodium zincate solution. After thorough rinsing to remove the viscous zincate solution adhering to the surface, a copper strike was applied from a Rochelle copper solution. To prevent poor adhesion caused by attack upon the zinc film, potential was applied to the aluminum prior to immersion, and the free cyanide content in the solution was kept low.

The chromium plated specimens were obtained with this plating technique and modifications. In certain specimens, for example, no copper strike undercoat was employed. Chromium was deposited directly over the zincate layer. This was done to prevent possible corrosion reactions between the aluminum base and the copper undercoat, which could occur because of extensive penetration of the porous chromium deposit by corrosive media.

One modified method of depositing chromium directly over the zincated layer consisted of immersing the zincated specimen in cold chromium plating solution at 65 F with the current on and preset to 576 ASF. After a few seconds, the current was reduced to 432 ASF and the bath was gradually heated up to 131 F while current density was maintained. Plating was then continued at 131 F until the desired thickness was obtained. This procedure, while preventing blistering which normally results from direct plating in the hot chromium solution, may be undesirable for producing large quantities of specimens.

A variation of this method consisted of immersing the specimen in the cold chromium solution with the current on and preset to 576-720 ASF. This current was maintained for 10-15 seconds and then reduced to 432 ASF for 10 minutes. The specimen was transferred to a second chromium solution at 131 F and a current of about 50 ASF was applied for several seconds. Then the current density was slowly raised to 432 ASF in about 5 minutes and maintained for the balance of the plating cycle.

Other specimens were plated directly in the chromium solution after special mechanical preparation to roughen the surface; no pre-treatment was made. The duplex chromium-nickel plate followed the zinc immersion copper strike process.

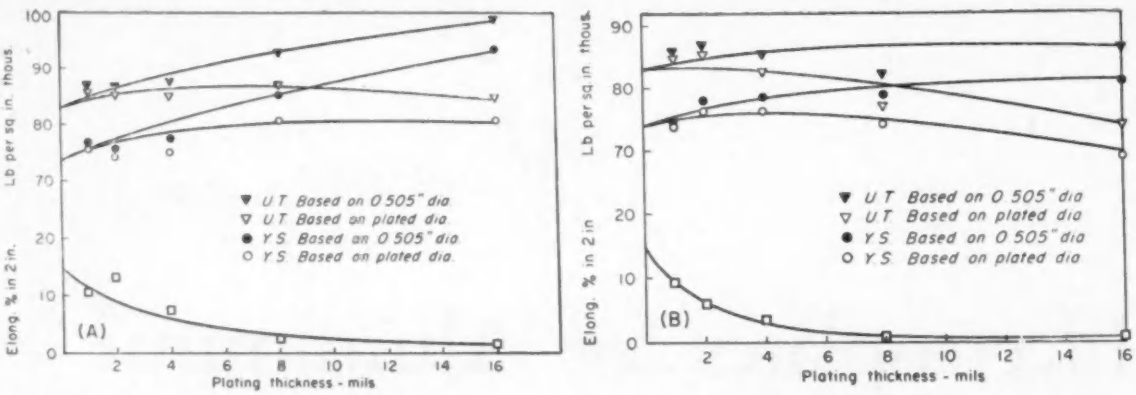

Lb per sq. in. thous.
Elong. % in 2 in.
U.T. Based on 0.505" dia.
U.T. Based on plated dia.
Y.S. Based on 0.505" dia.
Y.S. Based on plated dia.
(A)
(B)
Plating thickness - mils

Fig. 1—Ultimate tensile, yield tensile, and elongation values for (A) Pinner nickel plating (B) Bright nickel plating (C) Hard

MECHANICAL STRENGTH PROPERTIES

The electroplated specimens for which mechanical strength properties were obtained were both unexposed and exposed to corrosive conditions of salt spray and atmosphere.

In general, no substantial changes in ultimate tensile and yield strength were exhibited in unexposed nickel and chromium plated specimens up to about 8 mils in plated thickness, Fig. 1. Heavier deposits, however, with the exception of Pinner nickel, displayed a reduction in ultimate strength based on plated diameter. All deposits, with the exception of the duplex chromium-nickel plate, showed a reduction in ductility, percentage elongation dropping sharply for thicknesses up to 8 mils.

Elongation of the chromium plated specimens, however, was greater than that exhibited by those nickel plated. This might be attributed to the fact that, with chromium plate, the aluminum could freely deform plastically, while with the nickel plate it could not. Normally when aluminum alloys are stressed in tension above the elastic limit, plastic deformation, accompanied by a reduction in area, occurs progressively up to the point of fracture. Since chromium is much less ductile than nickel, it ruptured progressively due to its normal crack network. The aluminum alloys deformed semi-independently of their chromium plates, and were free to elongate in the direction of the applied tensile stresses.

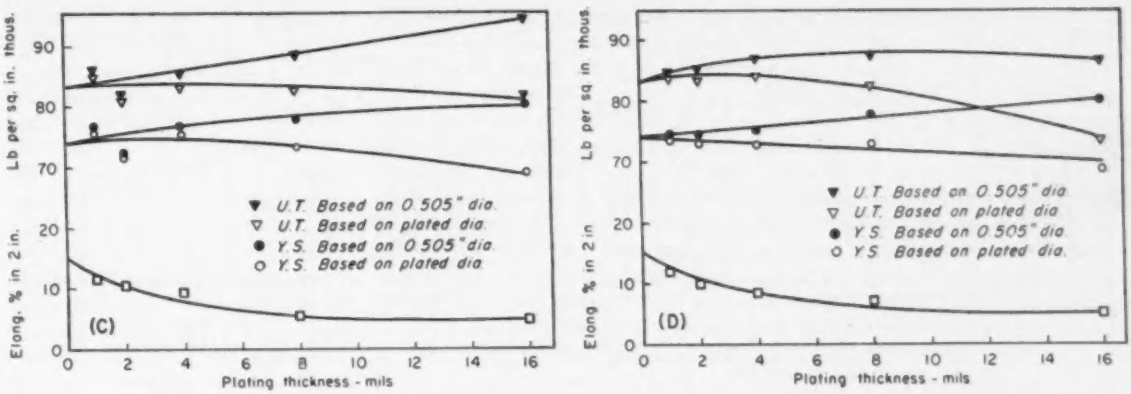
With nickel plate, the aluminum could not deform since the plate sets up tensile stresses normal to the direction of the applied stress and reduces the elongation. The ensuing stress pattern also caused the nickel plate to crack repeatedly around the circumference, Fig. 2. The single crack on the Pinner nickel is due to the greater ductility of this plate.

The tensile tests conducted on these plated specimens also substantiated the value of a copper undercoat as a good adhesion medium. Chromium applied directly to the zinc film shattered and completely flaked off at the ultimate load—a marked contrast to the strong adherence shown by the specimens prepared with a flash copper layer. This lack of adherence also increased percentage elongation over those normally plated.

During tensile tests, strong adhesion to the base metal was also exhibited by the duplex chromium-nickel layer. Elongation was greatly reduced and a fine network of wavy circumferential cracks appeared. The finer spacing and waviness of these cracks, Fig. 3, contrasted with the wider spacing and

Table V—Elongation of Exposed Specimens
(Average of three specimens)

Electrodeposit	Undercoat	Exposure	Elongation (Percent in 2")	Percentage Loss in Elongation
Control—no plate	.....	.....	14.4	....
	.....	4000 hours salt spray	7.0	51.5
Chromium—2 mils	Copper flash	None	10.5	....
	Copper flash	12 months outdoors	7.3	30.5
Chromium—2 mils	.....	None	14.2	....
	.....	4000 hours salt spray	5.2	63.4
	.....	19 months outdoors	9.5	33.1
Chromium—4 mils	Copper flash	None	9.2	....
	Copper flash	4000 hours salt spray	4.3	53.5
	Copper flash	12 months outdoors	8.3	9.8
Nickel—4 mils	Copper flash	None	3.7	....
	Copper flash	4000 hours salt spray	1.7	54.0
	Copper flash	12 months outdoors	3.7	....
Chromium-Nickel—2 mils each	Copper flash	None	7.5	....
	Copper flash	4000 hours salt spray	6.5	13.3
	Copper flash	19 months outdoors	6.8	9.3


Lb per sq. in. thous.
Elong. % in 2 in.
U.T. Based on 0.505" dia.
U.T. Based on plated dia.
Y.S. Based on 0.505" dia.
Y.S. Based on plated dia.
(C)
(D)
Plating thickness - mils

chromium plating (D) Low contraction chromium on Al75S-T6. Similar data were obtained for electroplates on Al24S-T4.

uniformity exhibited on nickel plating, Fig. 2, are undoubtedly due to the presence of the less ductile chromium outer deposit.

Table V presents elongation of exposed specimens. As shown, aluminum plated with chromium or nickel deposits, 4 mils thick, suffered marked elongation losses after 4000 hrs. salt spray exposure. These drastic losses were equivalent to that lost by the unplated controls. The same thickness of the duplex deposit limited this loss greatly. Again the improved performance obtainable with the duplex chromium-nickel deposit is clearly evident.

Fatigue strength studies were carried out using rotating beam specimens modified to eliminate the sharp shoulder and insure failure at the reduced central section. From these studies, it was seen that the fatigue strength of the plated specimens depends not only on the thickness but also on the type of deposit applied as well. The type of electrodeposit is a major determining factor in whether fatigue failure of a plated specimen will occur at a stress level lower or higher than that of the base metal. In general, most electrodeposits contain residual stresses in tension. When specimens protected with such deposits are stressed in bending, the tensile forces at the outer fibers are augmented, and fatigue failure occurs at a stress level lower than that of the base metal underneath.

Certain deposits, such as Bright nickel, are modified by the reagents in the bath and contain residual stresses in compression. When these specimens are subjected to a bending moment, the residual compressive forces counteract some of the applied tensile stresses. Failure of the plated metal then occurs at a higher stress level than that of the unplated metal. This is believed to be the reason for the Bright nickel plating exhibiting definite superiority over certain other plates that were tested in the same series.

Bright nickel plating, as shown in Fig. 4, shows an initial increase in fatigue strength while the other deposits

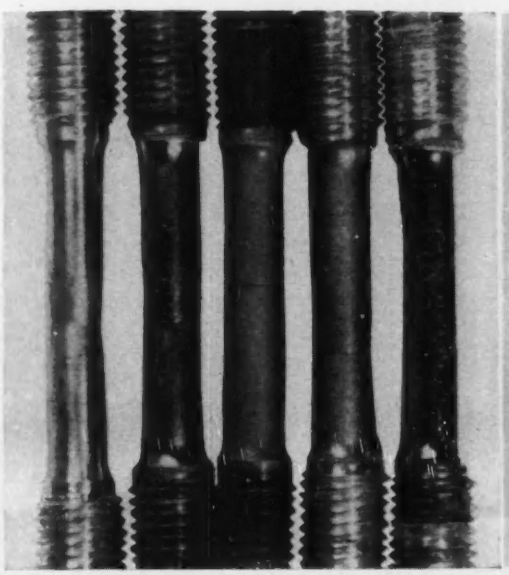
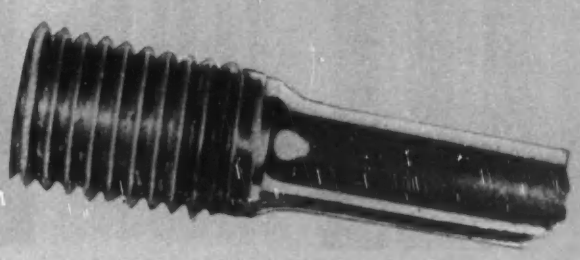


Fig. 2—Specimens after tensile testing. From left to right: Al75S-T6, unplated; Hard chromium plating; Pinner nickel plating; Hard nickel plating; Bright nickel plating.

Fig. 3—Duplex chromium-nickel plated aluminum alloy after testing. Finer spacing and waviness of cracks are due to less ductile chromium outer deposit.



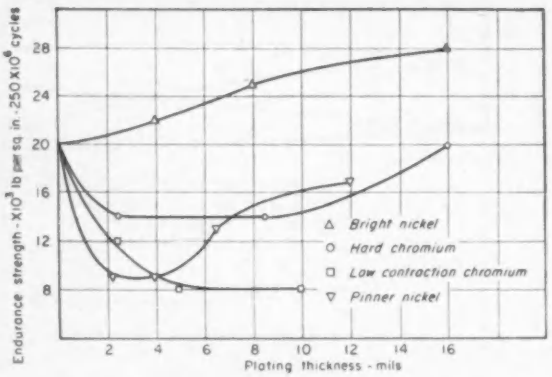


Fig. 4—Effect of plating thickness on endurance strength of plated Al75-T6. Bright nickel plating exhibits initial increase in fatigue strength, other deposits a decrease in strength.

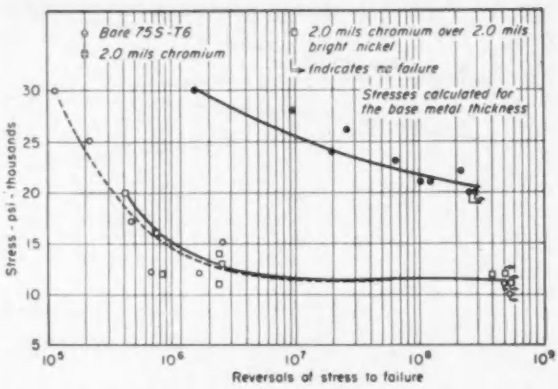


Fig. 5—Fatigue strengths of unplated Al75S-T6, chromium plate, and duplex chromium-nickel plate. Duplex plate exhibits sharp loss in fatigue strength.

exhibit a decrease. However as the deposits increase in thickness, other factors may influence stress distribution and affect behavior. A duplex coating, for example, with bright nickel as the underlayer does not perform in the same manner as a bright nickel plate. Although the bright nickel plating increased the fatigue strength of the alloy, it does not do so in the duplex plating, Fig. 5, indicating that fatigue strength appears to be determined by the outer deposit. Numerically, the strength dropped from 20,000 psi to 11,000 psi, a loss of 45 percent due to the chromium deposits which served as the outer layer.

CORROSION RESISTANCE

In salt spray and atmospheric exposure tests, the 2-mil chromium 2-mil nickel duplex plating displayed the most outstanding corrosion resistance, Fig. 6. The surfaces of the specimens appeared as bright and corrosion free at the end of the test as they did in the beginning. In salt spray exposure, no attack was evident after 2000 hours, and only one pit developed after 3000 hours, with no further advance at 4000 hours. Similarly 19 months exposure to the atmosphere had no visible effects on the duplex specimens.

On the basis of plated thickness, nickel plates were next in performance, Fig. 7. Heavy layers of nickel, 8 mils thick, remained unaffected after 4000 hours exposure to salt spray. Lighter deposits suffered pitting attack on scattered areas in shorter periods. However, in atmospheric exposure tests, these thinner coatings conferred adequate protection to the specimens. Nickel only 1 mil thick prevented corrosion of the underlying aluminum for approximately 16 months, although discoloration and darkening occurred.

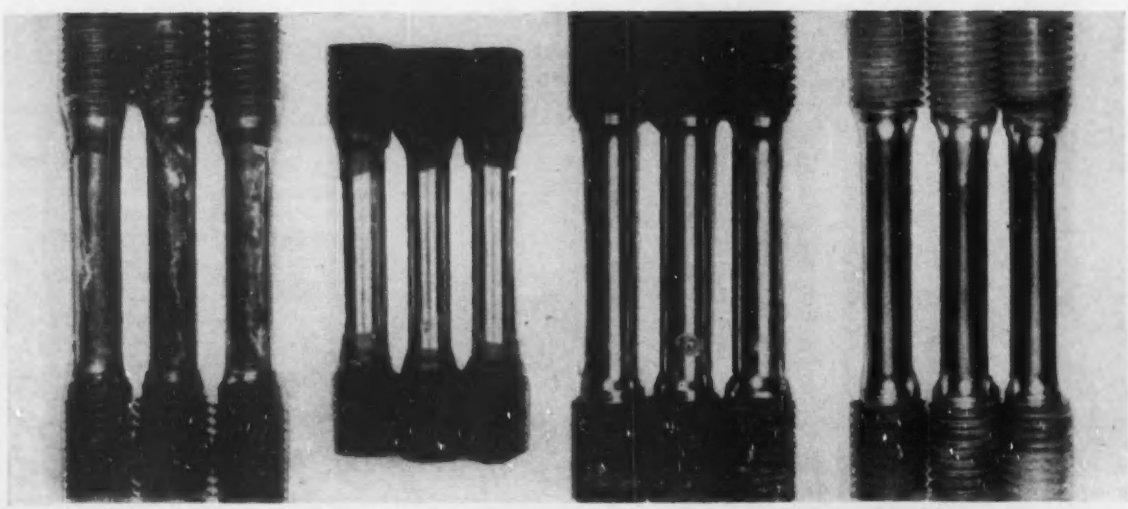


Fig. 6—Duplex chromium-nickel plated aluminum after exposure to salt spray and weathering. From left to right: Salt spray—2000 hrs, no pitting attack; salt spray—3000 hrs; salt spray—4000 hrs; weather exposure—19 months.

Chromium deposits with the copper strike undercoat were less resistant to corrosion than nickel, Figs. 7 and 8. After 2000 hours exposure to salt spray, marked pitting had developed in coatings up to 4 mils thick. After 4000 hours even the 8 mil specimens contained a few pits. Atmospheric exposure caused severe corrosion in the underlying aluminum, forming voluminous products which resulted in the buckling of the chromium layer. Examination of these specimens substantiates that the mode of corrosion is different in salt spray and atmospheric exposure. Salt spray, a conductive medium, causes pitting attack. Once developed, the pit offers local galvanic protection to a wide area around it. Such extended galvanic currents are not produced on specimens exposed to atmospheric conditions. Consequently, many small pits form closer together and cause a more general type of corrosive attack.

Chromium deposits without the copper undercoat showed no relative variation from those with undercoat in resistance to salt spray exposure. However, elimination of the copper undercoat appeared to have increased the resistance to weathering, but, as described previously, adherence of this plating to the specimen was extremely poor. Chromium plated directly on the aluminum with only mechanical preparation to roughen the surface suffered severe corrosion after 1000 hours of salt spray exposure. Again, the chromium deposit on the specimens broke off in large sections due to the swelling of aluminum corrosion products beneath the surface of this poorly adherent electroplate.

In the evaluation of these test results, therefore, it is evident that hard nickel and chromium electroplates for aluminum have certain merit, because of the improved corrosion resistance offered by the nickel plate and the outstanding corrosion resistance exhibited by the duplex coating.

An analysis of the data collected in this series of tests indicates that plated aluminum possesses many desirable properties and should have widespread application in components requiring lightweight and hard surfaces, provided they can function properly at reduced fatigue strength levels. Industrially, plated aluminum can be used for electronic components where hardness and corrosion resistance are required. Other possible fields of application for corrosion resistant deposits include the plating of extruded or ribbed sections which are not produced in clad form.

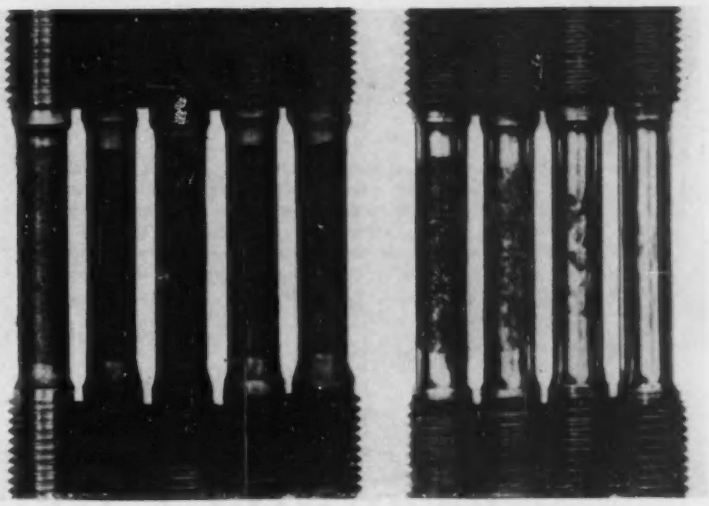


Fig. 7—Nickel and chromium plated aluminum after 16 and 15 months atmospheric exposure, respectively. From left to right: Uncoated; nickel, 1 mil; nickel, 2 mils; nickel, 4 mils; nickel, 8 mils; chromium, 1 mil; chromium, 2 mils; chromium, 4 mils; chromium, 8 mils. Nickel exhibits greater corrosion resistance. Corrosion in underlying aluminum resulted in buckling of the chromium layer.

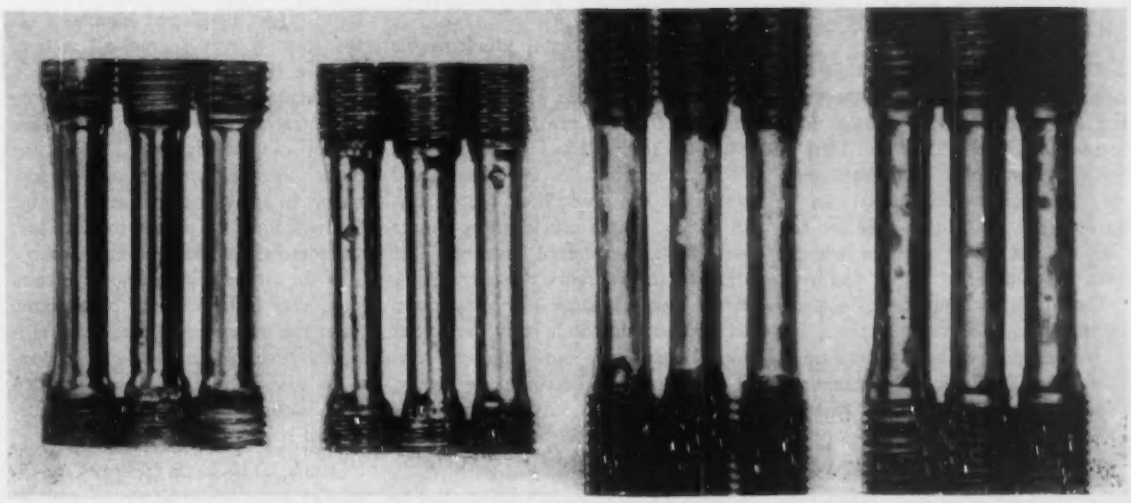


Fig. 8—Chromium plated aluminum after salt spray exposure. From left to right: Chromium plated, 8 mils, 2000 hrs; Chromium plated, 8 mils, 4000 hrs; Direct chromium plated, 3 mils, 2000 hrs; Direct chromium plated 3 mils, 4000 hrs.

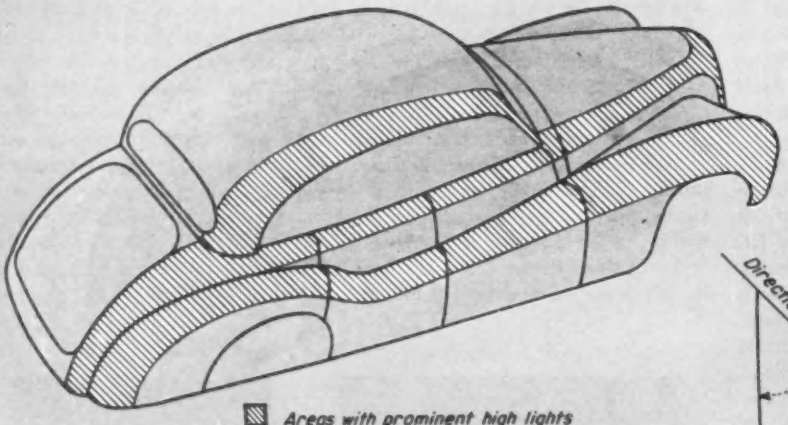


Fig. 1—In any styled product, it is the prominent lines of the surface that attract the eye and create a feeling of satisfaction. With a change in the relative positions of object and viewer, these lines move throughout localized areas. Careful attention must therefore be given to the contours in these areas in order that no undesirable hollows or bumps creep into the picture and spoil the overall effect of the product.

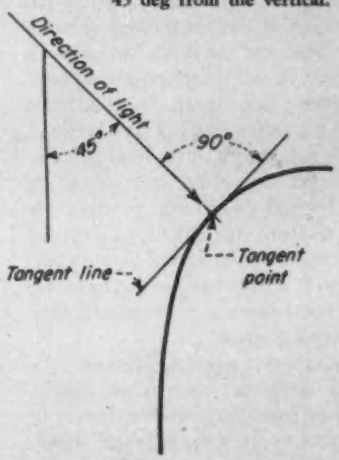


Fig. 2—Vertical section through typical automobile fender shows construction for obtaining the 45-deg tangent point. This is the point from which the light reflects when traveling downward at 45 deg from the vertical.

Designing Curved Surfaces

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WHEN DEVELOPING complex surfaces such as those found on automobiles and appliances, careful control must be maintained over lines and form so that they harmonize into a homogeneous, pleasing result. Lines can be manipulated easily since they are tangible and can be put on paper, whereas form has a different set of problems.

The appearance of curved surfaces depends upon the cross sections, but as these do not necessarily show up in the finished article, it is the manner in which light strikes an object that determines how the shape will appear. The directions of the high lights must therefore be known, in advance, so that strict control can be exercised over them. The method to be described eases this problem of control by reducing the amount of time and money spent in modifying models.

There are two main problems the engineer generally faces when designing curved surfaces: a model may be made by trial and error, perhaps based only on scanty drawing information. When the form is established and approved for production, unless it is of a very simple article, the engineer will have to produce drawings that describe the contours precisely. And, if the article is large and complicated such as an automobile body, the initial model may be in soft wood or clay. The contours will have to be proved on paper and any small discrepancies worked out on a full-size layout before final hardwood models can safely be made.

The second problem crops up when a full-size layout is made before proceeding with the model. Here the form is completely established on the layout from developed templates. If the form is very simple, all sections may be of the same type or family, permitting use of a curve based on mathematical derivation. Also, such curves can be developed from the master shape by proportional development. In any event, it is essential that the high lights be plotted to make sure surfaces look as they are intended.

If the article being designed is complex, very little help can be expected from the orthodox methods and it is highly desirable to develop the templates and high lights in conjunction with each other by the method described below.

Prominent High Lights

The automobile body in Fig. 1 has shaded areas that represent surfaces

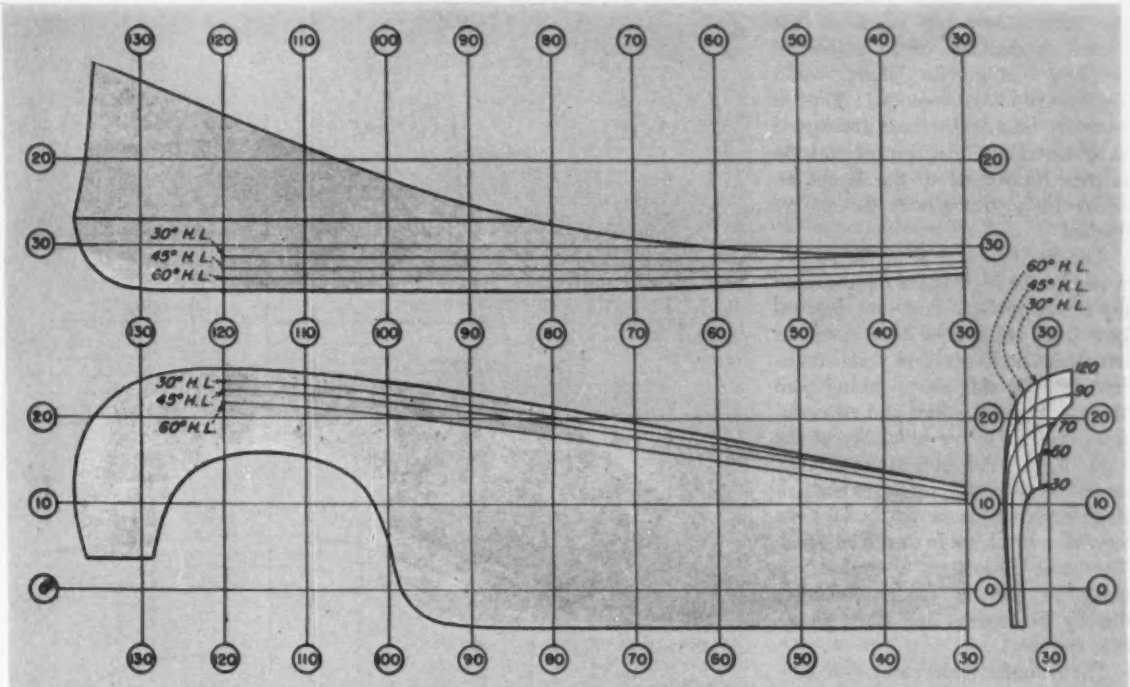

Fig. 3—Main views of automobile front fender reveal part of the important light lines. Based on the construction shown in Fig. 2, these light lines are plotted from vertical sections.

One of the problems in designing curved surfaces is to visualize shapes three dimensionally. The method described in this article permits control of surfaces at the drawing stage by manipulating lines that show the trend of the finished shape.

where the most prominent high lights occur; the remaining surfaces consist of semi-flat curves. The upper horizontal surfaces catch considerable top light which is spread over a large area and therefore does not show defined light lines. The problem here is to make sure that all surfaces flow smoothly with no undesirable hollows or bumps that might be distracting.

Plotting High Lights

The basic principle of plotting high lights is illustrated in Fig. 2, which shows a vertical section through the front fender of an automobile. If the light is travelling in the direction of the arrow, i.e., 45 deg to the vertical, it will reflect from the curved surface at the 45-deg tangent point. Assuming the source of light is an infinite distance away, it will reflect from every vertical section along the fender at the 45-deg tangent point. If vertical sections are cut at close intervals throughout the length of the fender and the 45-deg tangent point for each is plotted, these points can then be transferred to the elevation and plan views, and joined to form the 45-deg high lights. It will then be apparent whether the lines in the two views are smooth flowing and have the character desired. If the result is unsatisfactory, the developed light lines can be adjusted and new positions transferred to the cross sections which are, in turn, modified to agree.

Since the surface must look well with the light travelling from all directions, tangent points must then be plotted with the light travelling at various other angles. These are selected so that the whole surface being considered is adequately covered.

When making these plots, it is important to note that though the cross sections determine the high lights, the high lights predominate in the finished surface of the subject under study.

Proving Surfaces on Models

If a model has been made experimentally and the surfaces require proving, it is first necessary to make a full-size layout reproducing the surfaces exactly. Consider the automobile fender shown in Fig. 3 as a representative example.

The model is placed above and parallel to a plate on which there are 10-in. squares corresponding to body datums. Vertical 10-in. datums are scribed on the surface of the model and a female template made at each. Next, vertical and horizontal datums are scribed on these templates to permit accurate matching to the body datums on the layout. Points along

the bottom and top edges of the model are measuerd off in relation to the body datums for height, width and longitudinal location. This is necessary because the lines are curved in all directions. All this information is then transferred to the layout on which 10-in.-square body datums are marked.

The first step in proving the shapes, is to plot the high lights for the outer top curved surface. Forty-five deg tangent lines are applied to the vertical templates and the tangent points transferred to the side elevation and plan views. These are joined and an evaluation made as to the suitability of the high light. Adjustments are then made, if necessary, and the revised tangent points transferred back to the templates which are in turn readjusted. The same procedure is carried out using 30 and 60 deg high lights, thereby bracketing the most prominent surface.

The semi-flat side surface is considered next. As this surface does not produce prominent high lights, the only check necessary is one for smoothness and evidence of hollows and bumps. Horizontal lines are marked on the side elevation at not more than 5-in. intervals. The intersection with each vertical line is marked on the corresponding template and the width from center line of car transferred to the plan view. The points are then joined so that a plan view for each horizontal line is obtained. Here again the lines should flow smoothly from point to point and an evaluation made regarding the suitability of each shape. Any needed adjustments are made on the plan lines and vertical templates until they are all satisfactory and intersect each other accurately.

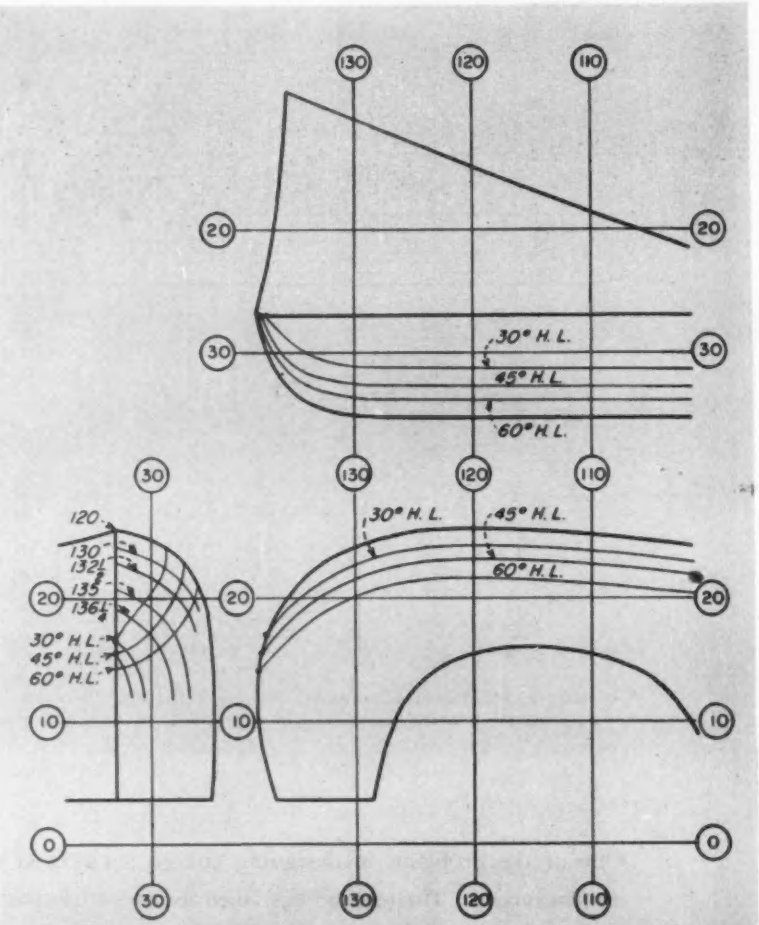

Fig. 4—Light lines of Fig. 3 are shown continued through nose of fender. Although this particular surface is good, the way in which the extreme front ends of the light lines change direction gives no indication of this fact. It is relatively unimportant that the underside of the nose is not reached because the front ends of the light lines are not at all prominent.

Designing High Lights

If there is no model available and the surfaces are to be developed on the layout, the method of approach can be explained by referring again to Fig. 3, which shows the front fender of the automobile.

The outline of the fender would first be designed in conjunction with the remainder of the automobile. Since all the lines are definite, little difficulty is experienced with handling them. Vertical sections are established at the 120 and 30 datums. On these sections 45-deg tangent points are marked and the points of maximum widths transferred to the plan and side elevation views. Lines connecting the points in the two views are then put in experimentally, and final adjustments made to suit the esthetic taste of the individual designer.

The next step is to check these shapes. First, a vertical section is cut approximately midway between the 30 and 120 datums, i.e., the 70 datum. Four points already appear on this template, i.e., top and bottom extremities, 45-deg high light and point of maximum width. A line is drawn through these points. If necessary, the two intermediate points are modified and transferred to the two main views, and the lines through these points adjusted until the 70 vertical template, and the 45-deg high light and maximum width line agree with each other and look well.

At this stage, the surface achieves some definition. The remainder of the development consists in adding vertical templates and horizontal lines in conjunction with each other until there is no doubt that the surface is satisfactory. Vertical templates are then constructed approximately midway between those last established, high lights at 30 and 60 deg added, and lines in elevation and plan views

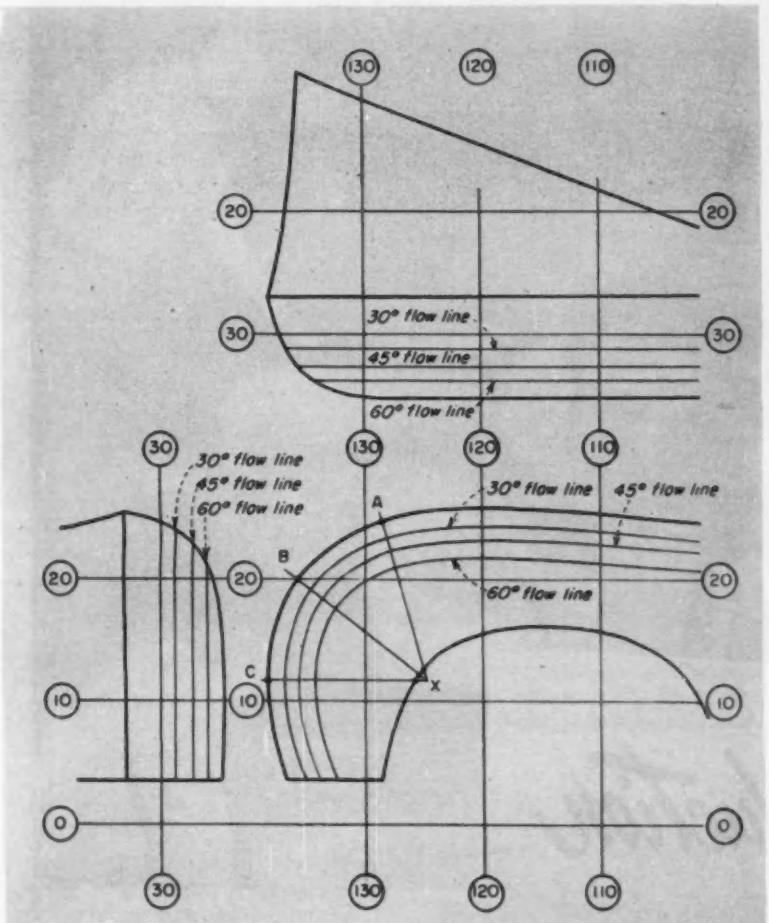

Fig. 5—Same surface as in Fig. 4 is shown with flow lines developed. These are plotted from sections cut radially to the fender crown line, using the construction shown in Fig. 2. Although these lines are not true light lines, they do define flow of contours and cover whole surface down to the bottom edge in a manner that is generally quite satisfactory.

of the semi-flat side surface lofted.

This method is largely one of trial and error, yet it allows freedom of artistic expression within the limits imposed by geometrical considerations. Furthermore, strict control is exercised over the prominent high lights.

Flow Lines

The surface considered so far is the simple shape between the 30 and 120 vertical datums in Fig. 3. The nose of the fender forward of the 120 datum presents special problems and calls for a slightly different treatment.

True high lights as developed from vertical sections continued forward on the fender appear in Fig. 4. These lines are of little use in developing the nose of the fender since they move over to the crown line and do not cover the bottom of the fender. Furthermore, these high lights are not prominent on the finished car and therefore do not require much consideration.

In a case such as this, a method is required that will ensure a smooth-flowing surface. Fig. 5 shows the method of developing the nose part of the fender in Fig. 3. The surface from the 120 datum to the rear end has already been developed, and the crown line as well as the outline of the fender established. The 30, 45 and 60 deg tangent points are indicated in plan and side elevation on the section at the extreme bottom of the fender. From these points, experimental flow lines are designed in the two planes so that they blend into the corresponding tangent lines at the 120 datum. Radial section lines *AX*, *BX* and *CX* are then drawn at regular intervals in the side elevation, Fig. 5, between the 120 datum and the bottom of the fender. From the lines already on the layout, the cross section at each of these lines can be plotted and an evaluation made of their quality. Any adjustments can be made to the cross sections and flow lines until they are all satisfactory and intersect each other accurately.

Although these tangent lines do not accurately indicate the high lights, they do give a good idea of the flow of the surface, and can be made to run smoothly into the true high lights.

Summary of Drafting Procedures

The examples chosen are necessarily simple so that the principles can be explained, but the methods can be adapted to the most complicated surfaces. To summarize, the four main principles are: (1) Surfaces which show prominent high lights are developed from sections parallel with each other, so that true high lights can be plotted; (2) where it is impracticable to develop from parallel sections, radial sections are used in conjunction with flow lines, (3) semi-flat surfaces which do not produce prominent high lights are developed with a view to the surfaces being smooth and without unwanted hollows or bumps; and (4) when designing any curved surface, the development lines must be in two directions, those in one direction crossing those in the other with the points of intersection having the same location in all views.

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Noise Reduction in Machinery

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NOISE is vibrational energy produced by a force in the form of sound pressure and the movement of air particles back and forth causing sound waves to be propagated. When a machine makes noise, some of its input power is being diverted from a useful function. This wasted energy is insignificant, however, since only a small amount of power makes a great deal of noise.

Noise in machinery is caused indirectly by forces that perform work and by other forces that are nonproductive. These forces are generally the result of either impact or friction and may be either intermittent or steady-state. When impacts occur in rapid succession, sometimes with regular periodicity, they tend to cause steady-state noise. Examples of this type of noise maker are gears, where the tooth impact noise becomes a pitched tone; and circular saws, where the teeth hit the work in rapid succession. In some instances, repetitive impacts give rise to steady-state noise caused by the ringing of a resonant component, especially when the impacts occur so rapidly that the resonant vibrations do not die out between impacts.

A frequent source of impact noise is lost motion in machinery, which may be remedied by designing closer fittings parts.

Frictional noise generated by gears, bearings, and cams is often a steady-state noise with a broad-band frequency spectrum. In many machines, the frequency components of frictional noise appear to be independent of the relative speed of the offending parts.

In gears, frictional noise is sometimes generated by an oscillatory rubbing of the meshing teeth. Many times the noise caused by broad-band frictional exciting forces tends to peak in certain frequency ranges as a result of the excitation of mechanical resonances in the rubbing parts.

Pitched tones are sometimes generated by a frictional phenomenon known as "stick-slip" action, which often occurs in the bearings of slow speed shafting. In stick-slip action, the friction is not continuous but comes and goes at a given repetition rate, which determines the frequency of the generated sound.

The various exciting forces in machinery cause its components to vibrate longitudinally, flexurally, and torsionally. These vibrations, known as structure-borne noise, are transmitted from one component to another, eventually either being sustained in the form of stored energy or dissipated. Each component radiates a part of its vibrational energy as air-borne sound. The amount and frequency range of the noise radiated by a given part depend upon its size and the ratio of its dimensions to the wavelengths of sound in air. Mechanical resonances in the components may cause widely different noise frequency spectra to be radiated by different parts driven by the same exciting forces.

In studying a machine with noise reduction as the object, an effective technique has been developed by the group with whom the author is associated. In this technique, the air-borne and structure-borne noise paths are traced through the components of the machine, and the relative importance of such paths is determined. In this experimental technique, the noise coming through one or more paths is attenuated, and the noise transmitted through other paths is analyzed. Such a study enables one to draw a schematic noise flow diagram that may indicate quantitatively and frequency-wise the contribution of each path to the total air-borne noise.

Such a diagram is shown in Fig. 1 for a machine, the main housing of which is attached to a heavy base mounted on the floor or bench. Some of the numerous components inside the housing are fastened to the base and others to the housing. The solid and dashed lines connecting the various schematic elements with one another represent paths for the transmission of vibration and air-borne sound, respectively.

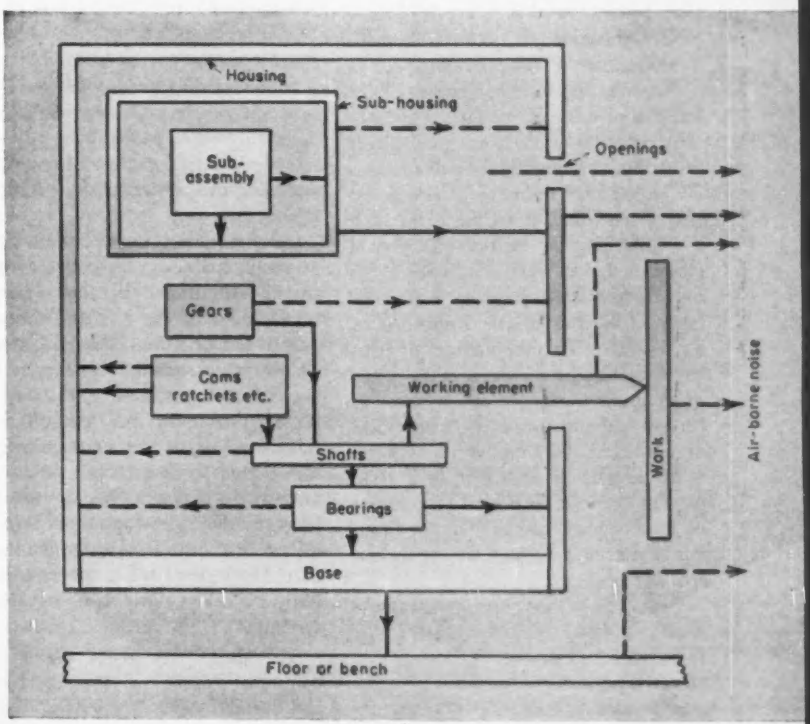
All of the vibrations and air-borne sound generated within the machine contribute something to the outside air-borne noise that reaches the ear. The sub-assembly transmits vibration to the sub-housing, which in turn transmits vibration to the main housing. The sub-assembly also radiates air-borne noise that strikes the inner walls of the sub-housing, causing them to vibrate and re-radiate air-borne noise to the inside of the main housing.

The gears, cams, ratchets and other mechanisms radiate air-borne sound inside the housing. They also generate vibrations, which are transmitted to the shafts, base, and housing. The shafts transmit vibrations to the bearings; these vibrations, plus any further vibrations that may be generated in the bearings, are transmitted from the bearings into the base and housing. All vibrations of the base and housing, of course, are transmitted into the bench or floor. The floor or bench thus vibrates and radiates air-borne noise. When its area is large, the bench or floor can be an important noise radiating source.

The air-borne noise radiated into the main housing, and the vibrations transmitted to it from the various components, cause the housing to re-radiate noise. The vibrations, however, are usually the worst offenders, except where the housing is made of thin sheet metal. The work producing element of the machine causes the work to vibrate and radiate air-borne noise. This working element, if large enough, may also radiate noise. Openings in the housing allow air-borne noise radiated within the housing to leak out.

For a specific machine, several well chosen noise measurement experiments can be conducted, using vibration isolation and other acoustical silencing treatments, and contributions of the various paths to the total noise level can be assigned. In this way, the machine components that are the worst noise sources can be determined, and methods of reducing the noise evalu-

Fig. 1—Noise flow in a machine. Solid lines are transmission paths of structure-borne vibrations; dash lines are paths for air-borne noise. The relative importance of each path is evaluated experimentally.



ated. A knowledge of the relative contributions of all the paths is necessary for an accurate evaluation.

During design, while the new machine or tool is still in the drawing board stage, all noise transmission paths should be visualized. An engineer with a knowledge of vibrating systems and isolation, sound absorption, and transmission can then design to attenuate the noise in those paths that appear to be the worst offenders. Concurrent with design, experimental models can be built for evaluating the effectiveness of any proposed quieting measures.

Changes of Operating Characteristics

Before considering quieting methods that call for some form of noise and vibration attenuation, the designer should think about changes in the operational characteristics of the machine. Such forethought is important because sometimes the achievement of desired noise reduction by vibration isolation methods requires compromises with mechanical requirements such as stiffness or alignment.

High rotational speeds, in general, tend to cause high noise levels as a result of vibrational exciting forces caused by any unbalance in the rotating member. Such speeds tend to produce noise at high frequencies and, at a given intensity level, high frequency noise is louder than low frequency noise. Rotating speeds, therefore, should be as low as practicable.

Another undesirable condition is to have the rotational speed or frequency of reciprocating parts in tune with mechanical or acoustical resonances.

Resonant machine components have families of resonant frequencies. Similarly, volumes of air in enclosed spaces of certain configurations have families of acoustical resonant frequencies. Any given resonant frequency of such a family may be excited into forced vibration by an oscillatory type exciting force within a given frequency range near that of the resonance or by impact. The magnitude of this resonant vibration, as well as the range of frequency over which it may be excited, depends upon the mechanical or acoustical damping in the system.

In design, therefore, it is a good plan to keep the rotational frequencies of shafts out of the range of the families of resonant frequencies of associated components.

Gear trains are nearly always a source of noise excitation forces that are transmitted to noise radiating surfaces. The noise is produced by the impact and friction of the mating teeth and usually includes a pitched tone, the vibration frequency of which is the product of the numbers of gear teeth and of shaft revolutions per second. In high speed rotation, gears with a large number of fine teeth may raise the tooth pitch noise above the audible frequency range. It is generally advisable to design the system so that the rotational speed and tooth frequency are out of the range of resonant frequencies of associated components.

The resonant frequencies of a machine component can seldom be calculated because of the complexity of shape of the component and the manner in which it is clamped or otherwise held in place. If the part is already made, however, its resonant frequency can sometimes be determined by striking it or driving it with an electromagnetic driver and comparing the tone to a frequency calibrated sound source.

The method of applying various forces to a machine or to the work is an important consideration in the noise problem. Many operations can be performed in one of several different ways in which the noise outputs differ greatly. Where the inertia of a moving part is converted into work, in general, the sharper and faster the impact, the louder the noise. Sharp impacts produce high frequency noise components; and, in some instances, high intensities.

To reduce noise, the machine designer should consider performing each machine function by methods other than by impact, or at least not with extremely fast or sharp impacts.

Effectiveness of Vibration Isolation

Where it is not practicable to make changes in the operating characteristics of machines, other methods of reducing noise may be effective.

One such method is vibration isolation. In general, vibration isolation is accomplished by mounting a vibrating unit upon resilient material instead of fastening the unit rigidly to its mounting surface.

Any vibration isolated unit has a resonant frequency associated with it that is determined by the resonance of the mass of the unit and the stiffness of the vibration isolating material. Below this resonant frequency, vibrational forces generated in the unit are not attenuated by the isolation material, but above this frequency the transmitted force decreases as the frequency increases. Near resonance, however, the force transmitted through the isolation material may considerably exceed that generated in the unit, especially if there is low damping in the system.

The transmitted force varies with damping. Vibration isolation curves are shown in Fig. 2 for two systems with different amounts of damping. The left-hand ordinate scale indicates the percent reduction of the transmitted force; the right-hand scale shows the transmissibility, or ratio of transmitted force to driving force. These parameters are plotted for different ratios of the driving frequency to the resonant frequency of the isolator system.

For zero driving frequency, or a static force, the force is transmitted unattenuated, or the transmissibility is unity. When the driving frequency is between zero and 1.4 times the resonant frequency, the force is amplified; and at higher frequencies is attenuated. Note that systems with low damping give better attenuation in the desirable operating range, but have the disadvantage of higher amplification near resonance. Where the isolated system operates at variable speeds, the designer may have to compromise on these features.

In the application of vibration isolators, it is important not to short-circuit or by-pass the isolator with rigid connections to the vibrating unit,

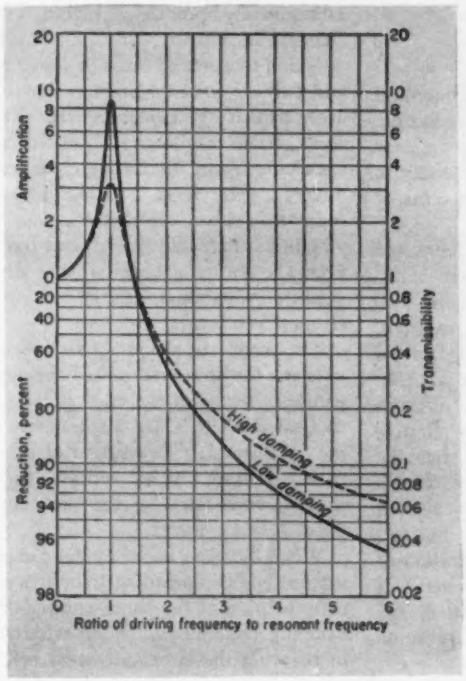


Fig. 2—Vibration isolation curves that show the reduction of transmitted force with frequency for two systems with different amounts of damping

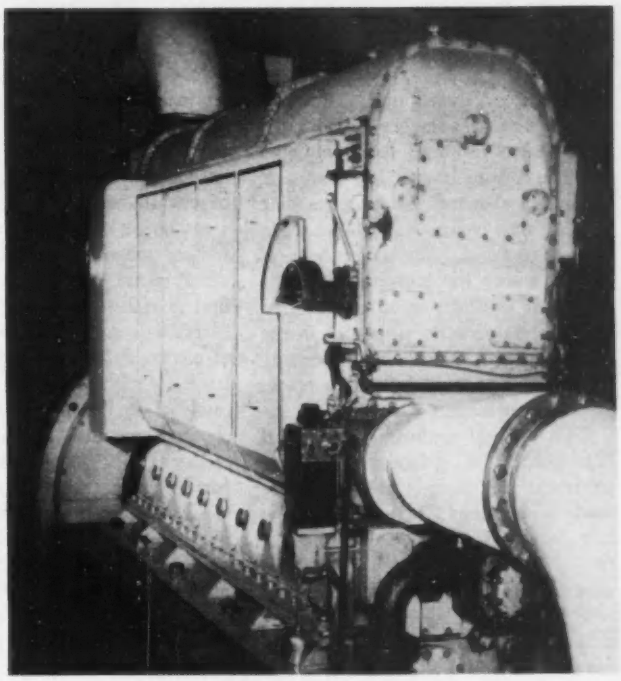


Fig. 3—Covers installed on the sides of a stationary diesel engine to reduce noise. Dark lines around covers are Neoprene strips for sealing and vibration isolation. Cover panels on side of engine are removable.

such as electrical conduit, pipes, and rigid shaft couplings.

Vibration isolation between some of the components of the machine may be practical when the design and construction of the machine permit. Also, the machine itself may be isolated from its mounting surface. If so, the isolation should be a permanent part of the machine to prevent it being discarded by the user. Frequently, a sub-assembly should be vibration isolated from the rest of the machine, especially when the sub-assembly generates considerable vibration.

Many mechanical engineers associate vibration with very low frequencies and think of vibration isolators as being made only of rubber or other very soft materials and, therefore, make the erroneous decision that isolation in certain applications will reduce rigidity or cause misalignment. Rubber and other compliant materials, however, are sometimes used effectively to isolate low frequency vibrations to prevent structural damage and fatigue failure.

The frequencies of noise in most machines that are loudest, however, are of the order of a thousand cycles per second. If so, vibration isolation can be obtained with materials that have less compliance than rubber but more compliance and damping than metals. Examples of these are Teflon and Nylon and various fibers. As long as the resonant frequency associated with the mass of the unit to be isolated, and the stiffness of the isolating material is well below the frequencies to be quieted, some degree of vibration isolation will be achieved.

Gears and cams can be isolated from their shafts by inserting compliant material between the wheel and its hub or shaft, or by making the spokes of compliant materials. Gears and cams can be made entirely of fiber when extreme strength is not required.

Vibrations of a shaft can be isolated from a connecting shaft by isolating couplings—again not necessarily made of rubber—if only high frequencies are to be isolated. A more practical method may be to isolate the shaft bearings from their mounting structures; or to use this method in addition to isolation of the rotating parts to achieve greater noise reduction.

The thickness and other properties of an isolator required to reduce the amplitude of the vibration transmitted by a pillow block to a flat surface to which the block is bolted can sometimes be calculated. An annular isolator around a ball bearing race, however, is more complicated to calculate and is best determined empirically by experimentation.

Vibration isolation of machinery housings from the machine structure, to prevent vibrations being transmitted into the housings and thus reduce the radiation of air-borne noise by the housing, is effective only if the housing is not being excited greatly by high-level air-borne noise inside it. In any such housing, of course, there should be no cracks or other openings through which this air-borne noise can escape.

When the functioning of machines, however, requires openings through which to feed the work, or for ventilation, there are effective quieting treatments. Tunnels for passage of materials may be lined with acoustical absorbing materials. Muffler-type structures can be installed for ventilation. Turns and bends in tunnels and air ducts are effective in keeping the noise from reaching the outside.

Acoustical Absorption and Insulation

Vibrations transmitted into the housing of a machine generally are the worst sources of noise. Extremely high airborne noise levels, however, are sometimes radiated inside a machine housing that contains little sound absorbing material. This noise bounces around within the housing, causing a somewhat uniform reverberant sound field that may excite vibrations in the most compliant surfaces of the housing or may be transmitted through cracks or other openings.

This internal air-borne noise level can usually be reduced by putting acoustical absorbing materials inside machine housings. Materials such as hair felt or glass wool are quite satisfactory. Many other materials are available for such applications, but care should be taken not to select abrasive materials that are likely to flake or chip off and get into bearings or other critical places.

The absorbing material can be covered with plastic sheeting a few thousandths of an inch thick to retain particles and to keep oil or grease from soaking into the material. Such plastic coverings do not seriously hamper the sound absorbing properties of the materials except at extremely high frequencies. Absorbing materials applied to reduce air-borne noise levels inside machine housings will result in lower noise levels outside the machines.

Noise levels around an electric typewriter, which was enclosed in a sheet metal housing, were reduced as much as 6 to 10 db in the middle frequency range by the insertion of Fiberglas inside the housing.

The addition of hoods or covers on machines that are already designed or in production is an economical method for obtaining noise reduction. A cover for the entire machine may be needed, or it may be necessary to cover only the noisy parts or areas of a machine's surface.

Cast metal covers and fabricated sheet metal covers are poor transmitters of air-borne noise. Lining such covers with sound absorbing materials, of course, further helps to prevent the build-up of reverberant sound. Because of their large smooth surfaces, covers sometimes are more effective radiators of air-borne sound than the part of the machine they cover. Therefore, when such a condition exists, it is important that vibration isolators be used to prevent the transmission of machine vibrations to the covers. If such vibrations are transmitted, the covers will become secondary noise sources.

A set of covers installed on a stationary diesel engine are shown in Fig. 3. They cover the entire sides of the engine where the worst noise sources were found. The covers are frames with several removable door panels and are made of heavy gage sheet metal. On the inside, the covers are lined with Fiberglas board weighing 9 lb per cu ft. The frames are vibration isolated from the engine with Neoprene. All cracks and openings are sealed where the frames come in contact with pipes and irregular surfaces. To obtain twofold attenuation of the engine vibrations, the individual cover panels are also vibration isolated from the frames.

These covers reduced the engine noise 10 to 12 db in the most objectionable frequency range.

Damping Materials to Reduce Noise Output

Large metal surfaces of machines and covers are sometimes excited into flexural vibrations. Any given surface has families of resonant frequencies that will be excited, therefore, the noise frequency spectrum radiated may not be the same as that produced by the primary excitation forces.

Increasing the damping of such surfaces may be helpful in reducing the noise output. A common example of this treatment is the spraying of undercoating materials on automobile panels and fenders. Such materials are also helpful in reducing machinery noise radiated by housings and covers.

Even though sprayed-on undercoatings are considered damping materials, they generally perform two separate functions: (1) To dissipate vibrational energy by mechanical resistance; and (2) to decrease the amplitude of vibration by providing higher mechanical impedance.

Sound transmitted through a wall or panel by its forced vibrations may be accompanied by resonances that reinforce certain frequencies. Damping is most effective in attenuating these resonances. The large bending amplitudes that occur during the resonant vibrations alternately stretch and compress the damping material, thus dissipating vibrational energy in mechanical resistance.

The materials are also effective in reducing the noise transmitted through panels by virtue of the mass added to the panels. The added mass increases the mechanical impedance of the panel, causing it to vibrate with smaller amplitudes for the same applied exciting forces.

When the mass added by the damping material is comparable to or greater than the mass of the panel, sprayed-on damping materials are quite effective in reducing the noise caused by resonances in panels and in reducing the forced vibrations of thin sheet metal panels at the lower frequencies. Rather unsuccessful attempts, however, have been made to reduce noise by spraying damping materials on heavy gage metal or castings in which resonances were not particularly objectionable and where the mass of the damping material was small compared to that of the metal.

Another method of obtaining damping is to spotweld or rivet several layers of metal together at numerous points. Flexural vibration causes these sandwiched layers to rub together, thus creating frictional damping. This type of treatment is most effective where vibration amplitudes are large. A variation of this arrangement is a laminated machine element composed of alternate layers of metal and fibre.

Conclusions

The most satisfactory approach to the problem of quieting machinery is a careful study of the individual machine design to determine what are the sources of noise and the important transmission paths, followed by an analysis of the most practical noise reduction treatment.

Better maintenance, holding lost motion to a minimum, and proper lubrication procedures will contribute greatly in the reduction of noise from machinery already in use.

The Fundamentals of Selecting Locknuts

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A CONFUSING VARIETY OF LOCKNUTS differing in principle, materials, method of manufacture, and cost is now available. While the primary purpose of all of them is to resist loosening under service conditions, one or more of several other factors may also be important if the best balance between performance and over-all cost is desired. In many applications, fastener cost itself is incidental when compared to the potential cost of a joint failure. In others, it may not be economically justifiable to use the best quality fastener.

Unfortunately, there are no simple rules or formulas that will pinpoint the best nut for a given application. All that can be offered is a list of factors that should be considered, with supplementary data based on years of observing the mistakes, questions, and needs of users in many different fields.

A guide to locknut performance for critical applications is given by aircraft specifications AN-N-5 and AN-N-10. After establishing strength and materials criteria, these specifications go into the question of torque. First, they set a maximum "first-on" torque. If this is too high, assembly will be difficult.

Next, starting torque is specified. This is the torque required to move a nut from any position where all threads are engaged, but the nut is not seated. A minimum value is set, since this is a measure of the tendency of a nut to stay in place.

A minimum prevailing torque is also specified. This is the torque required to keep a nut turning, once it has been started. It, too, is a measure of the nut's tendency to stay in place after assembly.

Regarding reusable life, the specifications set minimum starting and prevailing torques for nuts, to be measured after they have been turned on, and removed from, a bolt a given number of times. They specify that a nut damages neither bolt threads nor mating surfaces.

Finally, a vibration test is outlined. A test rig is described, which will subject a joint to impact and to vibration of different frequencies. After a given period, a nut must not have moved with respect to the bolt, and must not be capable of being turned by hand.

Most important in specifying locknuts is the question of how resistant to loosening and how reliable the joint must be. The different types vary widely in this respect. Several factors affect the answer. Some are pointed out in the accompanying table, but others defy such generalization. For example, in many applications maximum joint reliability is imperative—loss of life or damage to valuable equipment could result from loosening of a joint. In such cases, cost is no factor unless there is a cost difference between two nuts of the same reliability.

On the other hand, there are applications where reliability can be sacrificed to some extent in favor of cost. A fastener that meets the rigid AN specs may not be needed. Consider a household appliance which has a component attached with locknuts to prevent rattling. If an occasional joint loosens, no harm is done except that a service call is required. It might be needlessly expensive to use a top quality fastener to obtain maximum reliability. But it would not be permissible to have several joints loosen; service costs would become excessive, and the manufacturer's reputation would suffer. Somewhere in-between lies the answer. This is the type of decision that the designer must make in the light of his particular requirements. Some of the factors that determine what class of locknut (see pp 178-179) should be used are:

1. *Can the risk be run that occasionally something may accidentally be forgotten in assembly?* Class I nuts depend on a secondary element, such as a lock washer or a cotter pin. Not only might this be overlooked in assembly, but lock wires or cotter pins can break under severe vibration. Without the secondary element, these nuts are as free to spin as plain nuts. There seems to be little justification

for the popularity that still exists for this class. Probably it is partially inertia in resisting a change from practice and partially a reluctance to trust what seems like less positive methods. Actually many types often perform better.

2. *Can the nut be seated tight against the work?* Class V types lock only when they are tightly seated against one of the surfaces being joined. If any relaxation occurs, they are free to turn off. Such relaxation can occur due to creep of the bolt, wear or corrosion of mating surfaces.

3. *Is locking pressure spread evenly, or concentrated on a few threads?* If vibration is severe, the friction which prevents a nut from loosening should be spread over as large an area as possible. This requires expensive, precise manufacture. Some nuts lock with interference between a few threads or load some threads more than others.

4. *Are all nuts of a given type equally reliable?* Some classes of nuts are not uniform in their locking ability. The amount of distortion of shape which causes locking may vary from nut to nut. Also, these types cannot adjust to the normal variations of bolt diameter within normal tolerance limits. Thus, on bolts with diameters near the low limit, some nuts may not lock at all.

5. *Will the joint be exposed to high temperatures?* Some types of Class IV locknuts have plastic or other non-metallic inserts to obtain locking action, and are not recommended for use above 250F.

6. *Will the nut be frequently removed and reused?* Often, bolted joints must be broken periodically for inspection, repairs, access, or maintenance. The types of nuts which jam a few threads together for locking can damage bolt threads to the extent that the joint cannot be remade unless bolts are replaced.

7. *Is speed of assembly important?* It obviously takes more assembly time for nuts which require extra motions to lock, such as insertion of cotter pins or lock wires. With large volume production, this is an important factor.

8. *Is ease of assembly important?* When a locknut is required for a relatively inaccessible location, the free-spinning type, Class V, may be preferred.

9. *Will the nut damage the bolt or the work surfaces?* When a joint design is critical and maximum strength is required, stress raisers which jammed-on nuts can cause should be noted.

10. *Is there relative motion between parts bolted together?* If this is so, a castellated nut with pin or lock wire may be best, since repeated rotary motion might loosen other types.

All of these factors add up to locknut performance. Performance costs money. A precision-made nut, which fits all bolts within normal tolerance range, distributes locking friction evenly over all threads, can be removed and reused dozens of times, and locks anywhere on the bolt, whether seated or not, costs more to make than a nut which locks by means of threads distorted slightly by a hammer blow. A design must be analyzed to determine how much reliability and performance is required. On the other hand, it is poor economy to underestimate performance and reliability requirements.

BASIC CLASSES

CLASS I—Pins, Keys, Tabs, Safety Wire

Assembly is more costly than for other types, and there is the possibility of forgetting the locking member at assembly. Also, the very vibration which the locknuts are intended to withstand may cause fatigue failure of the pin, tab or wire. On the other hand, these types of nuts are most satisfactory where some relative motion exist between the respective part of the joint.

CLASS II—Deformed Threads

Widely used for moderate service conditions because of low original cost. Several factors limit their performance: (1) Locking friction is a result of high pressure in a few localized places; (2) Performance is usually erratic; (3) Cyclic loading and vibration can materially wear the interference points. Often merely loading the nut causes local yielding and a loss of locking torque. Also, deformed threads do not lend themselves to frequent reuse.

CLASS III—Secondary Spring Elements

These often give an attractive balance between cost and performance. Initial cost is usually low and reliability is adequate for many applications. Limitations: (1) Spring member may fail from vibrations; (2) Locking effectiveness is reduced or even lost if bolt stretches or mating surfaces wear; (3) Most nuts of this type tend to score the surfaces on which they bear.

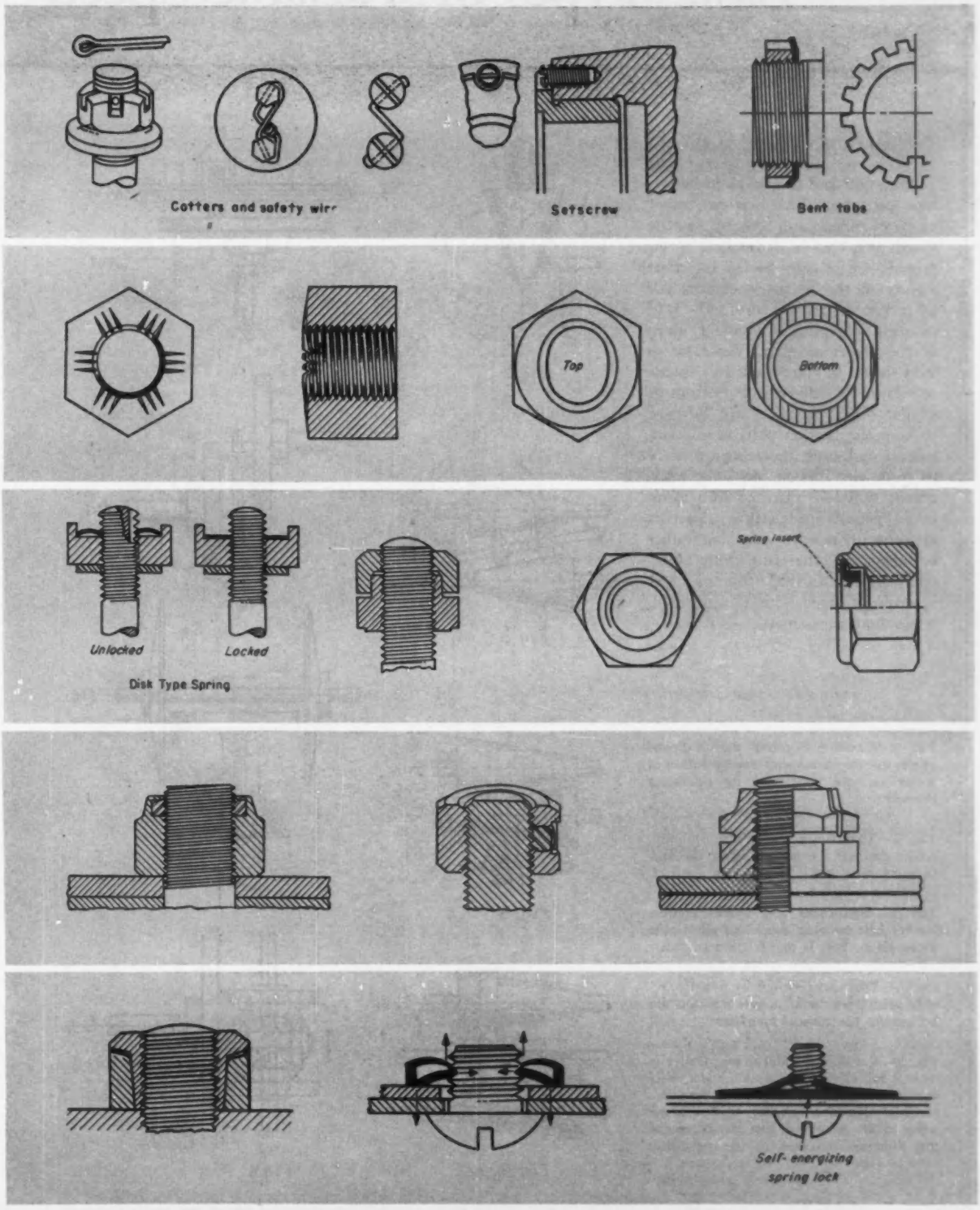
CLASS IV—Frictional Interference

Highest performance, but more expensive than any of the other classes. Locking action comes from plastic deformation of elements of the nut itself. These elements are either non-metallic inserts, or slotted collars. With either, spring-back tendency which produces action is uniform and does not depend solely upon bolt tension. Also these types need not be seated to lock. Reuseability is high. Operating temperature is limited.

CLASS V—Free Spinning

These include types that are free to spin until seated. Advantages: Easy and inexpensive installation; easily removed and replaced. Disadvantages: Any loosening of joint or loss of bolt tension converts them into free running plain nuts. Also, since the clamping force is in addition to bolt stress and is usually confined to the lower threads where load is already high, combined stress in these threads lowers the fatigue and impact resistance.

OF COMMERCIAL LOCKNUTS



Basic Types of Variable Speed

THESE DRIVES are used to transmit both high torque, as on power spindle presses, and low torque, as in laboratory instruments. All perform best if used to reduce and not to increase speed. All friction drives have a certain degree of slip due to imperfect rolling of the friction members, but by correct design this slip can be held constant, resulting in constant speed of the driven member. Variations in load should be compensated by inertia masses on the driven end. Springs or similar elastic members can be used to keep the friction parts in constant contact and exert the force necessary to create the friction. In some cases, gravity will take place of such members. Specially made friction materials are generally recommended, but leather or rubber are often satisfactory. Normally only one of the friction members is made or lined with this material, while the other is metal.

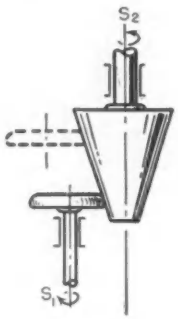


Fig. 1

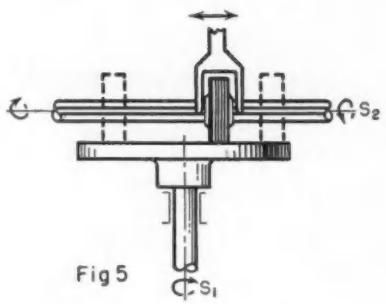


Fig. 5

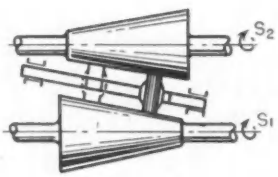
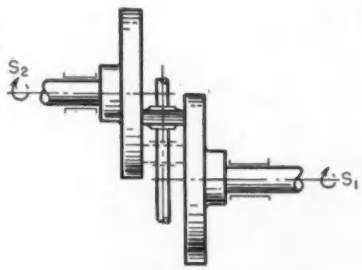


Fig. 2



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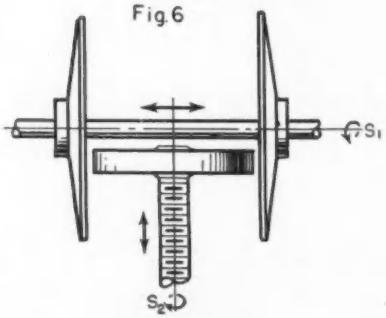

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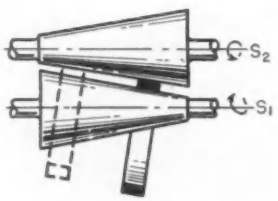

Fig. 3

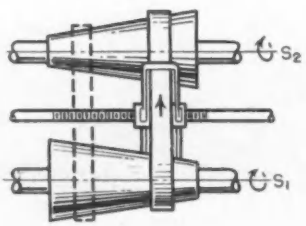

Fig. 4

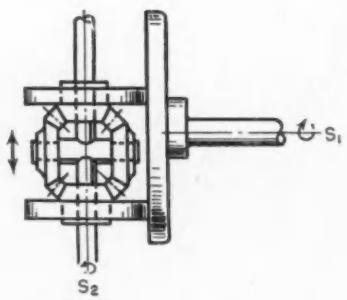

Fig. 8

Fig. 1—Cone and roller drive. Speed varies in accordance with axial position of roller on the cone and its operating diameter.

Fig. 2—Two cones and a free spinning roller that can be moved along the surfaces of the cones.

Fig. 3—Two cones and a free endless leather belt between them and adjustable along them. Belt is one friction surface.

Fig. 4—Two cones belted by a flat movable belt. Two metal fingers position the belt along the conical members.

Fig. 5—A disk and roller drive. Roller is moved radially on the disk. Speed will change according to operating diameter of disk. Direction of rotation is reversed when roller is moved past the center of the disk as indicated by dotted lines.

Friction Drives

HAIM MURRO

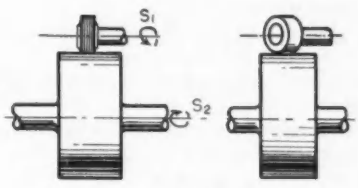

Fig. 9

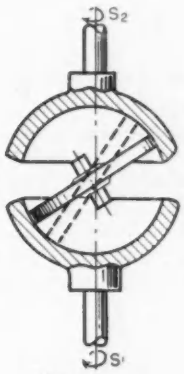

Fig. 13

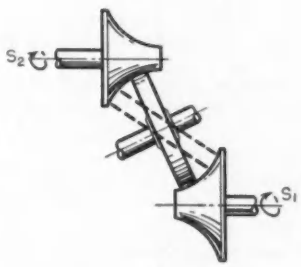

Fig. 10

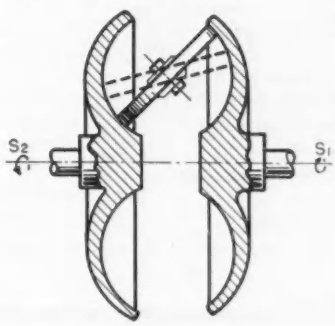

Fig. 14

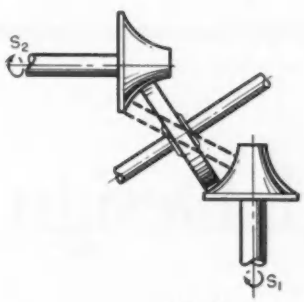

Fig. 11

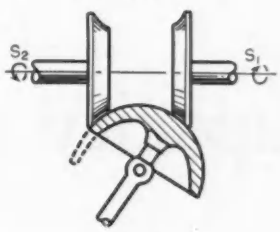

Fig. 15

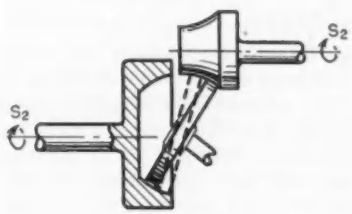

Fig. 12

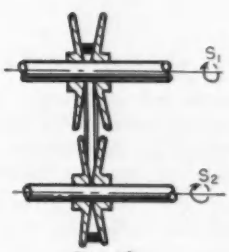

Fig. 16

Fig. 6—Two disks and a free spinning roller, movable between them. Change of speed will be fast, because of change of operating diameters on both disks.

Fig. 7—Two disks mounted on same shaft and a roller mounted on a threaded spindle. Contact of roller can be changed from one disk to the other to change direction of rotation. Rotation will be accelerated or decelerated with movement of the screw.

Fig. 8—Disk and two differential rollers. Rollers and their bevel gears are free to rotate on shaft, S_3. Other two bevel gears are free to rotate on pins connected by S_2. Good for high reduction and accurate adjustment of speed. S_1 will have the differential speed of the two rollers. The whole differential assembly is movable along the face of the disk.

Fig. 9—Drum and roller. Change of speed is effected by skewing the roller relative to the drum, so that only a component of its speed, tangent to drum, is effective.

Fig. 10—Two spherical cones on parallel shafts and a free spinning roller.

Fig. 11—Two spherical cones on intersecting shafts and a free rotating roller.

Fig. 12—Spherical cone and groove with a roller. Suitable when small adjustments in speed are desired.

Fig. 13—Two concave spherical disks and a free rotating roller adjustable on the center of sphere.

Fig. 14—Two disks with torus contours and a free rotating roller.

Fig. 15—Two disks with a spherical free rotating roller.

Fig. 16—Split pulleys for V belts. Effective diameter of belt grip can be adjusted by controlling distance between two parts of pulley. The two pulleys are adjusted simultaneously.

NOMENCLATURE

A = area of friction surface, sq in.
A_C = area of exterior surface of clutch, sq in.
b = effective outside width of clutch, in.
c = specific heat of clutch plate material; for cast iron and steel, $c = 0.12$
D_{AV} = average diameter of rubbing surfaces, in.
D_C = outside diameter of clutch, in.
D_I = inside diameter of rubbing surfaces, in.
D_O = outside diameter of rubbing surfaces, in.
E_H = energy dissipated in heat per clutching operation, ft lb
E_L = energy stored in load and rotating parts on load side of clutch, ft lb
f = coefficient of sliding friction, Table II
F_D = drive torque pulsation factor, Table I
F_L = load torque pulsation factor, Table I
F_S = starting torque factor, Table I
F_W = wear factor
h = heat transfer coefficient for rotating clutch, Btu/hr/sq ft/deg F difference; see Fig. 5
J = polar moment of inertia of load and load-side rotating parts as referred to the axis of the clutch, slug ft^2
M_A = average running torque, lb in. = 63000 multiplied by drive horsepower divided by rpm of clutch
M_B = torque needed to overcome bearing friction and windage on load-side of clutch, lb in.
M_L = inertia torque of load and load-side rotating parts, lb in.
M_M = torque capacity required of clutch, lb in.
n = speed of motor or engine side of clutch, or speed of clutch while engaged, rpm
N = number of pairs of rubbing surfaces; usually one for cone clutches
N_C = number of clutching operations per hour
p = rubbing pressure on elementary area of plate during clutching, psi
p_{AV} = allowable average pressure for friction materials as specified by manufacturer, psi; see Table II
P = total axial clamping force, lb
Q = heat generated in one clutching operation, Btu; (1 Btu = 778 ft lb); see Eq (15)
r = distance from axis of friction element in friction surface, in.
R_F = radius at which the friction force can be considered to be concentrated, in.
t = time of clutching required to bring the load from standstill up to clutch speed, sec
T_{AM} = initial or ambient temperature, deg F
T_{AV} = average temperature of clutch exterior, deg F
T_M = maximum temperature of clutch plates, deg F
V = rubbing velocity of friction material on an elementary area of plate during clutching, ft per minute
$V_{AV} = 2\pi n\ R_F/12$ = average rubbing velocity of friction material on plate at instant of surface contact, ft per minute
W = weight of clutch plates, lb
Y = fraction of cycle time in which the clutch is rotating. Fraction of cycle time in which the clutch is idle equals $(1 - Y)$
α = slant angle of cone in cone clutch, deg; Fig. 2
β = face angle of worn friction disk, deg; Fig. 3
θ = central angle subtended by an element of area of disk surface, deg; Fig. 1(A)

Torque Capacity and Design

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Consulting Engineer

THE USUAL STARTING POINT in clutch design or selection is the determination of required torque capacity. This capacity should be sufficient to deliver the torque required by the load on the driven machine and provide for any momentary peaks that are anticipated in the particular service.

Using the symbols as defined in the accompanying Nomenclature, the torque capacity M_M required of the clutch is approximated by

$$M_M = M_A \sqrt{F_S^2 + F_D^2 + F_L^2 - 2} \quad (1)$$

The driver and load torque peaks usually do not coincide, but are out of phase much like the discharge of a triplex pump. In Eq (1), therefore, the starting torque factor F_S, the drive torque pulsation factor F_D, and the load torque pulsation factor F_L are averaged on a probability basis by taking the square root of their sum. In Table I are given values of F_S, F_D and F_L for different conditions of starting load, characteristics of the prime mover, and type of driven load.

When the torque M_L of the inertia load to be started is relatively high in comparison with the average running torque M_A, clutch requirements are sometimes established on the basis of the maximum time allotted for the clutch to lock into the load by using the equation

$$\begin{aligned} M_M &= M_B + M_L \\ &= M_B + 12\ J\ (2\pi n/60t) \\ &= M_B + 1.25\ Jn/t \end{aligned} \quad (2)$$

Table I—Torque Adjustment Factors for Different Operating Conditions

Starting Factor, F_S		Drive Factor, F_D		Load Factor, F_L	
Free start with no load	1.0	Non-pulsating (3-phase motor)	1.0	Non-pulsating (Centrifugal blowers and pumps; generators under steady load)	1.0
Average inertia load	2.0	Moderate pulsation (single-phase motor; multi-cylinder engine)	1.5	Moderate shocks (Line shafting; multi-cylinder pumps; screens; woodworking machinery)	1.5 to 1.75
High inertia load (ball mills, etc)	3.0	Severe pulsation (single-cylinder gas engine)	2.0	Severe shocks (Cranes; shovels; single-cylinder compressors; rock crushers)	2.0 to 3.0

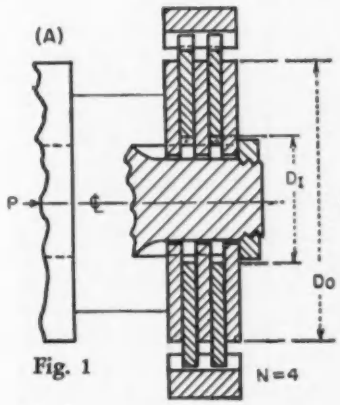
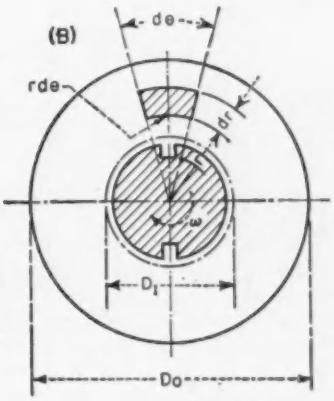


Fig. 1



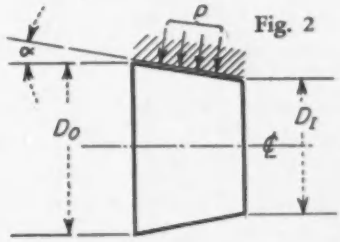


Fig. 2

Fig. 1—(A) Disk clutch with four pairs of friction surfaces. (B) Element of the friction area in clutch disk surface.

Fig. 2—Dimensions of cone clutch that has one pair of friction surfaces.

# of Cone and Disk Clutches

In Eq (2), M_M is the pound-inches of torque required to move the load from standstill up to the speed of full clutch engagement in t seconds at constant acceleration.

Depending on the service conditions, either the mechanical or the thermal torque capacity may be the criterion for the design of disk, cone, or plate clutches.

Where the criterion is mechanical torque capacity, disk and cone clutches of the type shown in Figs. 1 and 2 are designed such that their dimensions and materials of construction satisfy the equation

$$M_M = PNfR_F/F_W \sin \alpha \qquad (3)$$

The radius R_F at which the friction force is considered to be concentrated is usually taken as the average value

$$R_F = (D_O + D_I)/4$$

In a disk clutch, Fig. 1, sin α equals 1. In a cone clutch, Fig. 2, the value of α is usually selected so that sin α is slightly greater than the coefficient of friction f. Clutches having smaller angles are self-locking and require a force to release the members after engagement. The slant angle α of the cone usually is within the range of 10 to 45 degrees.

The wear factor F_W takes into account the reduction of clamping force that results from the wear of friction linings, operating cams, and toggles. This factor also includes an allowance for a reduction in the coefficient of friction as a result of heating and dirt. For F_W a value between 1.25 and 1.5

Table II—Properties of Metallic and Nonmetallic Friction Materials

Values given for Sliding Friction Coefficient are conservative. They allow for glazing of clutch surfaces, for dirt and for other adverse operating conditions. When possible, these values should be checked with the manufacturer of the lining material.
Values given for Allowable Average Pressure depend on the condition of service. The values given for the "$p_{AV}\,V_{AV}$" product are the allowable power loading (ft lb/minute/sq in. of friction material).

Contact Surfaces		Sliding Friction Coefficient, f		Maximum Temperature, F	Allowable Average Pressure, p_{AV}	$p_{AV}V_{AV}$ Product	
Wearing	Opposing	Wet	Dry			Wet	Dry
Cast bronze	Cast iron or steel	0.05 to 0.10		300	80 to 120		
Cast iron	Cast iron	0.05	0.15 to 0.2	600	150 to 250		
Cast iron	Steel	0.06 to 0.10	0.12 to 0.15	500	120 to 200		
Hard steel	Hard steel	0.05		500	100		
Hard steel	Chrome plated hard steel	0.03		500	200		
Hard-drawn phos. bronze	Chrome plated hard steel	0.03		500	150		
Powder metal	Cast iron or steel	0.05 to 0.10	0.1 to *0.4	1000	100 dry 300 wet	41,000	13,000
Powder metal	Chrome plated hard steel	0.05 to 0.10	0.1 to *0.3	1000	300	41,000	13,000
Wood	Cast iron or steel	0.16	0.2 to 0.60	300	60 to 90		250
Leather	Cast iron or steel	0.12 to 0.15	0.3 to 0.50	200	10 to 40		
Cork	Cast iron or steel	0.15 to 0.25	0.3 to 0.50	200	8 to 14		
Felt	Cast iron or steel	0.18	0.22	280	2 to 10		
Vulcanized fiber or paper	Cast iron or steel		0.3 to 0.50	200	10 to 40		
Woven asbestos	Cast iron or steel	0.1 to 0.2	0.3 to *0.6	350 to 500	50 to 100		1000 to 1500
Molded asbestos	Cast iron or steel	0.08 to 0.12	0.2 to *0.5	500	50 to 150		1000 to 2500
Impregnated asbestos	Cast iron or steel	0.12	0.32	500 to 750	150		
Carbon graphite	Steel	0.05 to 0.1	0.25	700 to 1000	300	150,000	15,000
Molded phenolic macerated cloth base plastic	Cast iron or steel	0.10 to 0.15	0.25	300	100		

* For a specific material in this group, the coefficient is usually maintained within ± 5 percent.
Data on the newer materials are compiled from information obtained from the American Felt Company; The Felters Company; Johns Manville Corporation; Raybestos-Manhattan, Inc.; The S. K. Wellman Company; and The United States Graphite Company. Data on allowable pressures and coefficients for the older materials are taken largely from V. L. Maleev.

should be used for single disk clutches, and between 1.5 and 2 for multiple disk clutches.

Values of the sliding coefficient of friction f and the allowable average pressure on clutch surfaces are given in Table II for different combinations of facing materials.

As derived, Eq (3) gives the resistance to slipping after engagement.

The torque exerted by the clutch during engagement may also be calculated from Eq (3) by adjusting the value of the axial clamping force P. During engagement the net force applied to the clutch members is the clamping force P minus the frictional resistance exerted by the driving lugs, splines, or teeth while the clutch members are being forced into engagement.

Frictional resistance is negligible at the start of the clutching operation but may increase to as much as ten percent per plate of the applied force when full torque is developed. The amount of loss depends on how well the parts are lubricated and on the location of the lugs.

During clutching, the effective axial clamping force becomes progressively

less, plate by plate, down the length of a multiple disk clutch. This decrease in clamping force, together with the need for adequate cooling, establishes the maximum practical number of disks.

After engagement, the axial clamping force is eventually equalized over the plates with the assistance of creep and vibration.

In a cone clutch there is an additional temporary loss in the applied clamping force. This loss results from the friction between the cone surfaces while they are moving into engagement. The net force available for clutching is usually taken as

$$P \sin \alpha/(\sin \alpha + f \cos \alpha)$$

Certain simplifying assumptions are made in the derivation of Eq (3). One fact there disregarded is that rivet holes and scavenging grooves in the lining surface often reduce the friction area to 90 percent or less of the swept area used in the equation. Manufacturers of friction linings, however, base their maximum pressure recommendations on the swept area. A correction should be made only when the swept area is reduced more than 25 percent by heavy grooving.

Also, in deriving Eq (3) it is assumed that the average value for the friction radius is $(D_O + D_I)/4$. The validity of this assumption depends on the rigidity and accuracy of the clutch parts and on the effects of thermal distortion and wear.

For an exact theoretical determination of the friction radius R_F, the distribution of pressure over the face of the disk or cone must be known. Since exact information is seldom if ever available for a given clutch, one of two assumptions is usually made regarding the distribution of pressure.

In a new and accurately-made clutch, it may be that the pressure is distributed uniformly over all the elements of area. A formal integration based on this assumption of uniform pressure (Ref. 1) results in

$$R_F = (D_O^3 - D_I^3)/[3\,(D_O^2 - D_I^2)] \quad (4)$$

In a clutch with D_I equal to 0, Eq (3) gives a 33 percent greater allowable torque when the value of R_F as defined by Eq (4) is used instead of an average radius equal to $(D_O + D_I)/4$. With an inside diameter D_I equal to at least half the outside diameter D_O, which is usual in disk clutch design, the discrepancy is less than 3.7 percent. As the friction area narrows, the discrepancy continues to diminish; when D_I is 70 percent of D_O, the discrepancy is only 1.2 percent.

In a rigorously correct analysis, it is considered wrong to accept the assumption of uniform pressure distribution, except for a new clutch with rigidly supported friction linings. The reason: Wear changes the pressure distribution.

With all things being equal, the rate of wear on each element should be a direct function of the rate at which work is done on each element. The wear rate, when temperature is uniform, should be a function of the rubbing pressure p and the rubbing velocity V. On this basis, the wear of two elements of area should be the same when the pV products are equal.

If it is assumed that in a new clutch the pressure is uniformly distributed, then a new clutch should initially wear most rapidly at the outer edge where the rubbing velocity is greatest. In time as the clutch is used, the friction surfaces should wear from flat to conical shapes, Fig. 3, until the pV products of the elementary areas are equalized.

A mathematical analysis of a disk clutch, Fig. 1, on the basis that the wear rate of the elementary areas becomes equalized and is a function of the product of rubbing pressure and rubbing velocity, leads to an unexpected conclusion.

Where β is the face angle of a worn friction disk, Fig. 3, the area dA of any friction element located a distance r from the axis is $rd\theta\ dr/\cos\beta$; the normal force exerted on this element is $prd\theta\ dr/\cos\beta$; and the torque exerted by the friction element is $fpr^2d\theta\ dr/\cos\beta$. The total torque M on the rubbing surface, therefore, is

$$M = f(1/\cos\beta)\int_o^{2\pi}\int_{D_I/2}^{D_O/2} pr^2 d\theta dr \quad (5)$$

Since pV for uniform wear is constant, and since V varies directly with r

$$p = k/r, \text{ where } k \text{ is a constant} \quad (6)$$

The maximum pressure p_{MAX} will occur at the smallest radius r, or $D_I/2$. Then from Eq (6)

$$k = D_I p_{MAX}/2 \quad (7)$$

substituting Eq (7) in Eq (6)

$$p = D_I p_{MAX}/2r \quad (8)$$

substituting Eq (8) in Eq (5) and integrating, the torque M transmitted by one pair of rubbing surfaces is

$$M = (\pi f\, D_I p_{MAX}/8\cos\beta)\,(D_O^2 - D_I^2) \quad (9)$$

The axial clamping force P acting on the surface of a plate can be derived by the integration of

$$P = \int pdA = \int_o^{2\pi}\int_{D_I/2}^{D_O/2} \left(\frac{D_I\, p_{MAX}}{2r}\right)\left(\frac{rd\,\theta\,dr}{\cos\beta}\right)$$

$$= \frac{\pi\, D_I\, p_{MAX}}{2\cos\beta}\,(D_O - D_I) \quad (10)$$

or $D_I p_{MAX} = 2P\cos\beta/[\pi(D_O - D_I)]$ (11)

Substituting Eq (11) in Eq (9) results in

$$M = fP\,[(D_O + D_I)/4] \quad (12)$$

The term contained in the brackets of Eq (12) is the value of R_F assumed for use in Eq (3).

One might properly ask how well does the foregoing analysis, and in particular the conical wear shape postulated in Fig. 3, agree with experience. Contrary to theoretical expectations, an examination of worn automotive clutch plates showed that they were slightly more worn on their inner areas than on their outer areas.

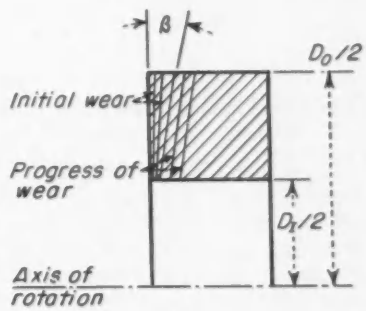


Fig. 3—Theoretical change in shape of a disk clutch as the friction surfaces wear from flat to conical shapes.

The expected pattern of wear, however, is often altered by plate deflection under load, by plate warpage from heat, and by the temperature variations between the inner and outer peripheries of the clutch depending on the path along which heat is dissipated.

These considerations, coupled with

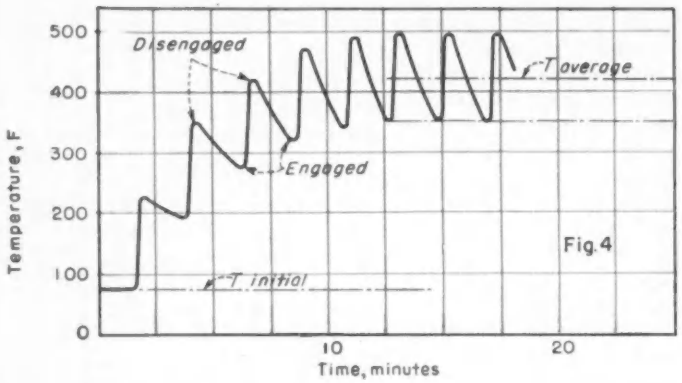


Fig. 4—Temperature changes in the exterior surface of a clutch that is successively engaged and disengaged many times per hour. Temperature rises until rate of heat dissipation is equal to rate of heat input.

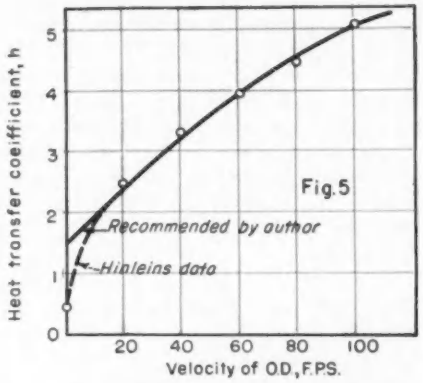


Fig. 5—Combined values of heat transfer coefficients for radiation and convection for different peripheral speeds of clutch exterior.

the uncertainty of the coefficient of friction, warrant the use of Eq (3) whether the clutch is old or new.

The theoretical relationship between the axial load P and the maximum developed pressure p_{MAX} as given in Eq (10) for a worn-in clutch has little practical design value. Data on the maximum allowable unit pressure on friction materials are seldom available. It is standard practice for manufacturers to calculate the average pressure p_{AV} sustained by a material and to give this value in catalogues.

Where p_{AV} is taken from manufacturer's data or from Table II, the allowable axial loading for clutches of any design should be calculated from

$$P = p_{AV} A = \pi p_{AV} (D_o^2 - D_i^2)/4 \quad (13)$$

THERMAL TORQUE CAPACITY

In starting a load with a friction clutch, of course, slipping occurs until the load comes up to clutch speed. Assuming a constant coefficient of friction and a constant axial clamping force, the energy lost in heat per clutching operation is the work done by the clutch per revolution multiplied by the difference between the number of revolutions made by the motor or engine side of the clutch and the number of revolutions made by the load side of the clutch during the time t of clutching.

Where

M_M = clutch torque resulting from constant axial clamping force P, in. lb see Eq (3)

$2\pi M_M/12$ = work done by the motor or engine side of clutch per revolution, ft lb

$n\,t/60$ = revolutions made by motor or engine side member during clutching period

$n/2$ = average speed of load side clutch member from standstill to running speed, rpm

$(n/2)\,(t/60)$ = revolutions made by load side clutch member during clutching period

the energy E_H dissipated in friction per clutching operation is

$$E_H = (2\pi M_M/12)\,[(nt/60) - (n/2)\,(t/60)] = (4.36 \times 10^{-3})\,n\,t\,M_M \quad (14)$$

The time t of slip is usually between 0.1 and 5 sec; the high values are usual for large clutches. Rather than guess, however, time t can be calculated by an inversion of Eq (2) if the load characteristics are known.

The heat Q generated per clutching operation is

$$Q = E_H/778 = (4.36 \times 10^{-3})\,n\,t\,M_M/778 = (5.61 \times 10^{-6})\,n\,t\,M_M \quad (15)$$

The kinetic energy E_L or work stored in the load and the rotating parts on the load side of the clutch at speed n is

$$E_L = (2\pi n/60)^2\,(J/2) = (5.45 \times 10^{-3})\,n^2 J \quad (16)$$

Neglecting the term M_B in Eq (2)

$$M_M = 1.25\,n\,J/t \quad (17)$$

substituting Eq (17) in Eq (14)

$$E_H = [(4.36 \times 10^{-3})\,nt]\,(1.25\,n\,J/t) = (5.45 \times 10^{-3})\,n^2 J \quad (18)$$

then from Eqs (16) and (18)

$$E_L = E_H \quad (19)$$

The equality of Eqs (16) and (18) means that where bearing friction and windage losses can be neglected, and where inertia is the only significant load, the energy dissipated in the clutching operation is equal to the kinetic energy imparted to the load and rotating parts on the load side. The sum of E_H and E_L, of course, is the energy supplied by the drive in the clutching operation.

It follows also that the heat generated in starting an inertia load with a clutch is equal to the heat that would be generated in stopping the same load with a brake.

Where the frequency of clutching operations is such that the temperature of the clutch mass returns to its initial or ambient temperature T_{AM} between clutching operations, the maximum temperature T_M reached by the clutch plates can be approximated from

$$T_M = (Q/cW) + T_{AM} \quad (20)$$

When clutching is so frequent that the clutch does not cool completely between its operations, the peak temperature and the average temperature rise with each successive engagement as indicated in Fig. 4. These temperatures rise until the rate of heat dissi-

pation is equal to the rate of heat input. Heat is dissipated primarily by convection and radiation; conduction along the shaft is usually small.

The maximum heat rejection rate of a clutch design depends upon the evaluation of many factors. These factors include: Surface emissivity, ambient temperature, effective radiating area of heat source and heat receptor zones, effective convecting area, amount of ventilation and resulting effects on the convective heat transfer coefficient, and temperature distribution throughout the clutch.

Because the value of these many factors can only be approximated, it is impossible practically to calculate precisely the maximum heat rejection rate for a new clutch design or application. An estimate, however, can be made that will indicate whether or not a particular condition is critical.

As a first step in the development of a new clutch design, the following equation is presented

$$T_{AV} - T_{AM}\,[Yh + 1.5\,(1-Y)] = 144\,Q N_C / A_C \qquad (21)$$

Following the practice in heating and ventilating calculations, the heat transfer coefficients for radiation and convection are lumped in the term h in Eq (21) and made independent of temperature but dependent on air velocity.

Suggested values for the combined heat transfer coefficient h are given in Fig. 5 for a range of velocities of the outside surface of clutch housing. These data have been adapted by the author from data given by Hinlein on page 378 of the 5th edition of Mark's Handbook. The value of h at zero velocity has been adjusted upward by the author as indicated by published catalogue clutch data.

The true sawtooth time-temperature relationship and the thermal gradient from inside to outside of clutch are neglected in Eq (21). When the clutch is operated at temperatures much in excess of 400 F, the rate of heat rejection by radiation increases rapidly and the Stefan-Boltzmann equation should be applied.

To obtain maximum clutch life, the average temperature T_{AV} of clutch exterior in Eq (21) should be 100 to 150 deg F less than the temperature limit of the lining material as specified by the manufacturer. These lower temperatures allow for temperature differentials and peaks in operation.

For a cut-off clutch, the surface area A_C of the clutch exterior in Eq (21) can be estimated as

$$\pi\,(D_c{}^2 + 2\,D_c b)/2$$

This estimate should be adjusted for designs where the clutch exterior varies from that of a plain straight cylinder; for example, a housing with fins and ribs, or a truncated cone shaped housing.

If the clutch is cooled by air scoops, the heat transfer coefficient h as given in Fig. 5 should be increased by 20 to 50 percent.

No allowance is made in Eq (21) for heat conduction along the shaft or to other parts, on the basis that such heat dissipation is negligible. This assumption would not be true for a clutch bolted on a flywheel.

In the form given, Eq (21) is conservative and agrees with catalogue ratings of several manufacturers within a tolerance of 50 percent. In the form given, the equation is proposed for use as a first approximation. Suitable performance tests, however, should be made with a prototype before the clutch design is adopted for quantity manufacture.

Some measures that can be taken to reduce overheating and thus prolong the life of clutch facings, are:

1. Increase Clutch Mass thereby reducing the magnitude of the instantaneous temperature rises. If weight is objectionable, aluminum or magnesium backing plates may be of benefit. These metals have a relatively high specific heat to compensate for their low density, and their high thermal conductivity facilitates the transfer of heat from friction surfaces to the clutch exterior.

2. Increase Heat Transfer Area. Increase exterior surfaces by using fins, ribs and flanges. Such projections increase mass as well as the rate of cooling.

3. Increase Convective Coefficient of Heat Transfer. In a dry clutch, add fan-like vanes or air scoops to increase air flow. When clutches stand idle for much time, supplemental fans or auxiliary blowers increase the rate of cooling.

One widely known magnetic clutch employs radial slots in its fluted armature backing plate to serve as a centrifugal blower. To help prevent thermal distortion, segmented friction facing in this clutch forms additional air passages.

4. Increase Radiative Coefficient of Heat Transfer by improving the emissivity of the radiating surfaces. Avoid bright polished exteriors; use dull black finishes and as-cast surfaces.

5. Avoid Heat Traps. Critical analysis of troublesome designs has sometimes revealed air gaps or insulating material between the rubbing surfaces and the heat dissipating surfaces. For efficient performance of a friction clutch, an adequate heat path must exist.

In experiments to evaluate the merits of automotive brake shoe designs (Ref. 2), it was noted that drum and liner temperatures drop rapidly at first as shortening of the arc of liner from 360 deg exposes more drum area to circulating air. The minimum wear rate was reached at about 220 deg total liner arc length. At shorter lengths, any improvement in cooling was offset by the disintegrating effect of the increased unit pressures on the liner material.

6. Use Materials Having High Heat Resistant Properties. Semi-metallic asbestos friction linings contain copper powder to increase the transfer of heat away from the contacting face, as a result the allowable average pressure and temperature for this material is high, see Table I. Powder-metal friction materials are highly conductive and resist deterioration at spot temperatures that cause asbestos fiber to lose its water of crystallization.

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TECHNICAL NEWS

MARTIN MATADOR, PILOTLESS BOMBER, roars off roadable launcher at Air Force Guided Missile Test Center, Cocoa, Florida. Brightly colored stripes on nose make tracking by camera crews easier and assure a sharp image on photographs.

GUIDED MISSILE TEST RANGE

LONG RANGE GUIDED MISSILES, potentially tremendously devastating weapons, are ready to leave the paper stage: the next step is to evolve techniques for testing preliminary designs as they roar over long distances at speeds up to 3,000 mph.

There's no precedent for such a proving ground operation. Missiles are one-shot affairs, usually non-recoverable after they had been launched. Since their function is to "hit a target," a complete test includes a study of the impact. That means all data must be gathered by external sensing devices. And there is no second chance to correct test mistakes. In addition, engineers demand an exceptionally high degree of accuracy in such experimental data.

Firing Range

To meet this unique testing challenge, the U. S. Air Force has under construction what will someday be a completely automatic proving ground —automatic from missile launching to data evaluation. When it is completed, the firing range will stretch 1,200 miles—from multiple launching pads on Florida's Cape Canaveral to the seventh and last down range instrumentation station on the Southwestern tip of Puerto Rico. The Air Force will operate this facility so that civilian contractors will have some place to bring their newly designed missiles for test.

Headquarters for the Air Force Missile Test Center (AFMTC) is located at Patrick Air Force Base, Cocoa, Florida. Military scientists stationed here have evolved plans for the proving ground installation slowly, building the range in stages, because of the unfamiliarity with the problem. Today, instrumentation stations on Mayaguana and Grand Turk Islands are nearing completion. These boost available test distance to over 800 miles. The last stations in the chain—one in the Dominican Republic and the other on Puerto Rico—will not be ready for at least another year.

Instruments

Estimated cost of the completed range is $200,000,000, of which over $75,000,000 represents an investment in instruments—optical, electrical and electronic. One of the most eye-opening features about AFMTC is the way these sensing tools are being used.

Based on their function, missile testing instruments can be classified into three groups: (1) Those that measure external characteristics and supply the data from which such items as trajectory, velocity, acceleration, roll, pitch and yaw—all versus time elapsed—are determined. (2) Those that measure parameters of aerodynamic and engine performance with transducers and then telemeter data back to ground stations. (3) Those that analyze experimental information, reduce it to usable form,

make the complicated calculations necessary to evaluate performance and then plot it.

Tracking Missiles

In the first group, cameras and radar are the workhorses. Optical instruments provide the most accurate data as to missile position as well as supplying a visual record of the flight. But the films require chemical processing, and that takes time. Also, position is calculated with trigonometric relations requiring information from at least two accurately located cameras. And cameras need good weather for best operation.

Radar, on the other hand, continually reports the position of the missile as the flight proceeds. It is an all weather instrument, just as effective in day or night. During an actual test, both track the missile. Film records are used to plot the trajectory accurately. Radar records have a triple function: To warn range officers during a test if the missile wanders off a safe course and heads for populated areas (in which case a safety officer can destroy it); to back up cameras if weather should hide the missile or mechanical malfunction interferes with photographing; and to check the calculations obtained from film data.

Telemetering Data

Another major source of test data is the telemetering equipment. Use of a transducer to pick up information and relay it to a control point is not new, but the sophistication of such gear in guided missiles is rarely duplicated elsewhere. Miniaturized equipment, sturdy enough to stand extreme acceleration and shock, is capable of reporting between 50 and 100 bits of information—some of it continuously, others in pulses.

Down range instrumentation stations play their biggest role in telemetry. There is a definite line of slight limitations for the FM/FM signals. Maximum range depends on the height of the projectile at any instant. To make sure of getting all data, AFMTC tries to pick up all telemetered information by at least two stations. When testing very low flight missiles, it is sometimes necessary to use flying relay stations mounted in old B-17 aircraft to insure continuous receipt of information.

When a test is completed, films, radar records, and magnetic tape recordings of telemetered data are rushed to a data evaluation group where the material is sorted and processed. As the information is assembled, it is placed on punched paper tape to be fed to AFMTC's new computer—FLAC, for Florida Automatic Computer. Today, a final report can be prepared within as short a time as one week after a missile launching. When missile testing first started, it sometimes took five months.

Although the present range is an impressive installation, it is only a shadow of what is planned. Now AFMTC launches as many as three or four missiles a week for a relatively short distance—200 mile-tests. Scientists are planning for the day when there will be multiple launchings, three or four at one time over the entire length of the range. And they are also talking of sending missiles down to Puerto Rico, turning them around, and dropping them into the ocean off the launching site—a round trip of over 2,500 miles.

Industrial Designers Meet

TWENTY YEARS AGO, a few rugged artists plied the profession of industrial design, prettying up products when they could convince the manufacturer that it would help sell the product. Today, members of this fast-growing profession design the majority of the country's mass produced products. Proof of the growth is indicated by the record turnout at the eighth annual Design Conference of the Society of Industrial Designers. Over 75 leaders in the field attended the October session; they heard a program that included these highlights:

• Jean O. Reinecke, President of the Society, keynoted the meeting with a discourse on the Philosophy of Industrial Design. He warned: ". . . There are far too few designers capable of creating designs which measure up to the demands of the public. Being different isn't a guarantee of superiority. Improvement can result only from change; but change does not always entail improvement. Fresh design isn't always refreshing to the average person. . ."

• George Nelson, designer and architect, spoke on "Design and Communication." One of his major points: designers try to communicate the meaning of an object through its design. He told the group; ". . . That people understand the communication is made clear by the record of sales. For they (consumers) consistently picked the most radical design, that is, the design which communicated the idea with the greatest force and the least regard for conventional styling. . ."

• Captain A. F. Van Dyck, Radio Corporation of America, alerted the designers to take advantage of the possibilities released by the successful development of atomic energy. Van Dyck predicted, ". . . The greatest influence (of atomic energy) will come from the improvements and new possibilities in existing branches of engineering and manufacture. . . ."

• Peter Muller-Munk, S.I.D. delegate to the 1953 Paris Industrial Design Conference, reported on European Design Trends. His opinion: European industry excels in the design and manufacture of hand-made luxury products. However, the average machine-made European product is inferior to the American standard. One exception to this might be in the Machine Tool Industry, where continental builders—with an eye to lush American markets—are doing much original thinking. Germany particularly will make a serious bid for a big share of the U. S. market.

• Raymond Loewy told the group that the designer had to act in both diplomatic and advisory capacities, but he urged his audience to preserve design integrity, because the best interests of a client are served only by a designer who has positive convictions in his own work.

S.I.D. is confident of the future of the profession. Retiring-president Reinecke said that the return of the buyer's market would place new emphasis on the importance of industrial design. He added that tougher competition for the consumer dollar increases the need for a saleable product that will sell competitively.

Last business at the meeting was the election of a new president, Robert H. Hose, partner in the New York Office of Henry Dreyfuss.

THE BUSINESS OUTLOOK

BUSINESS ACTIVITY in the U. S. will continue at a high level through 1954. Talk of recession and soft spots in the economy is premature, although the days of the easy sale and the super-boom are gone. These forces will continue to support business next year:

(1) Manufacturing industries will hold spending for new plants and equipment at a high level. Contrary to many expectations, expenditures should slide only about eight percent from 1953, which turned out to be another record year.

(2) Cutbacks in defense spending will not be as great as anticipated. Despite the uneasy peace in Korea, world affairs have deteriorated, forcing the U. S. to re-examine defense plans. Korea is still a hot spot, so is Indo China, and new trouble spots have developed in the Middle East.

(3) 1954 is an election year and that means politics will be at work full tilt. Republicans hold control of Congress by a thread, so the present administration will do everything to keep business levels high. Unemployment, spotty sales, and low profits would make too good ammunition for the Democrats.

(4) Consumers still have record savings, available for the purchase of both hard and soft goods. Retail sales, down in a very few spots, generally reflect this condition and remain steady.

Capital Spending

The good news for industrial equipment manufacturers comes from a survey of Business Plans for New Plants and Equipment, just completed by the McGraw-Hill Department of Economics. The study reports that major reductions stem from completed defense expansion programs; there is no evidence of widespread cutbacks in anticipation of a business recession.

Declines reflect the curtailment of new construction and expansion of capacity. Large plans still exist for installing new machinery, particularly in consumer goods industries. New products will be one of the main props supporting capital spending in 1954. This includes completely new products, more capacity for recently developed growth products, and the expansion of diversification of existing product lines. Big companies, particularly, are diversifying their manufacturing facilities, by bringing out completely new items, or entering other industrial fields with growth prospects.

Detailed spending plans are broken down by industry and reported in the table below.

Defense Spending

1953 started off as a year of heavy cuts in defense spending with the Air Force bearing the major brunt. But as the year developed, events forced a slow-down on funds slashing. Most sobering news: Russian claims about the H-bomb.

Therefore, in 1954, U. S. policy will be to increase expenditures in fields of immediate defense. Electronics will top the list because the Defense Department urgently wants to strengthen the radar network in Canada. More aircraft are next—Washington says a first-rate warning system is a waste of money without first-class interceptors to shoot down invading airplanes. Close behind, and possibly surging ahead, will be expenditures for guided missile development and testing (see page 188). And finally, there will be extra heavy expenditures for anti-aircraft weapons, particularly items like the automatic Skysweeper.

Political Effects

In the U. S., politics have always played an important role in business cycles. Just what to expect as next year's congressional elections roll around can be interpreted from the following dispatch filed by a McGraw-Hill Washington correspondent last month:

"What's happening in Agriculture shows the political jitters in Washington. Farm price supports will be pegged at 90 percent of parity. The Administration doesn't like the prospect. It prefers a flexible support system with pegs moving up and down in relation to supply. But the way the winds are blowing now, the Administration won't have much of a choice. If it doesn't change and back high-level supports, then Congress will force the supports."

The Rumor Mill

Businessmen are seriously concerned about recession rumors that keep cropping up without any apparent basis. They fear the country will talk itself

Expenditures for New Plant and Equipment
(Millions of Dollars)

Industry	Est. 1953	Plans 1954	Increase or Decrease
Steel	$1,460	$1,108	−24 percent
Automobiles	923	1,063	+15
Machinery	899	805	−10
Electrical Machinery	463	512	+10
Transportation Equipment	215	196	− 9
Food	841	841	0
Petroleum	2,824	2,757	− 2
Chemicals	1,800	1,546	−14
Textiles	296	260	−12
Other Manufacturing*	2,969	2,595	−12
Total Manufacturing	12,690	11,683	− 8

* Includes non-ferrous metals (refining and fabricating), building materials, containers, paper, rubber, furniture and apparel.

Source: 1953, Department of Commerce; 1954, McGraw-Hill survey.

into a depression. Washington has been a source of many such rumors, and there's an easy explanation why.

The nation's capital has been in a turmoil since the Republicans swept last November's presidential elections. Democrats moved out and Republicans moved in, causing confusion in real estate and apartment leasing. Then the Eisenhower economy drive cut the number of government employees by nearly 100,000, many of whom left the capital. Washington retailers felt the loss of this purchasing power as sales slumped. The decline started a lot of deflation gossip when observers reported the slump without noting that it was strictly a local affair. Elsewhere in the U. S., consumers—earning wages at a record clip—keep store cash registers ringing merrily.

DRY RADIOGRAPHY

AT ALUMINUM COMPANY OF AMERICA'S Cleveland Research Division, engineers are evaluating what should be one of the most significant developments of this decade in radiography. The new project: Xeroradiography, a technique that employs a re-usable dry plate to record the X-ray image.

Key to the process is the electrostatic method of reproduction pioneered by the Haloid Company to make duplicates of drawings, letters, etc. Static electricity arranges a fine-grain powder on a specially coated aluminum plate and produces an image similar to that on an X-ray film. General Electric Company supplied standard GE X-ray equipment for Alcoa's study. Battelle Memorial Institute also participated in the development of Xeroradiography.

Biggest advantage claimed for the process is what it does to developing time. With the new technique, an X-ray image is available for viewing within 45 secs of exposure. Conventional film usually requires about one hour to develop and dry for viewing. Such speed could open the use of X-ray inspection techniques in many new applications—even to the extreme of continuous instant production line inspection.

In addition, no dark room is necessary to prepare the image. A permanent record of the image on the plate can be made in a few seconds by photographic methods.

Japan's Titanium Industry

TOKYO—Japan's budding titanium industry, aimed at U. S. markets, has increased from nothing to a monthly output of 10.75 tons in the past twelve months. For the future, the industry plans to produce 200 tons per month in 1954; 12,000 tons a year before 1958.

But despite the impressive progress, the industry has tough sledding ahead. In Washington, there is little American interest in encouraging the manufacture of such a strategic material so close to Communist influence. The feeling is that a rapid expansion of Japan's titanium production would set Nipponese companies up for attractive propositions from Russia or Red China. And the sellers would probably not refuse offers two, three or four times the going U. S. market price, even if the bids originated in Red-controlled countries.

U. S. discouragement has taken the form of a 20 percent tariff on titanium sponge imports. That raises the price of the Japanese material from about $3.00 to $3.75 per lb, still competitive with U. S. produced sponge selling around $5.00 per pound. Japanese metallurgists hope to get costs down to $2.00 in the near future, but U. S. companies are close to lower priced production too.

At present Japanese companies export only titanium sponge. American buyers say it is too risky to ship any other form, since the slightest error in sheet or rod would mean rejection. Now all imports are being run through facilities of the DuPont Company in the U. S. for additional processing.

Japan's techniques are based on research done by Hiroshi Ishizuka. They use the chloridation method of extracting titanium from sand iron slag. New improvements of this technique are being incorporated. Most notable: a direct chloridation of the slag, eliminating the high cost of recovering magnesium.

Leading Japanese producer is Osaka Titanium Company, jointly owned by Sumitomo Metals Co, Kobe Steel Co., and Furukawa Electric Industry. A new company—Toho Titanium—is being developed by Ishizuka along with the Nippon Mining Co. and Daiichi Bussan Company.

Osaka Titanium produces about six tons of metal per month, and plans to boost output to 55 tons by next year. Other major producers: Japan Electric Metallurgy Company, Nippon Soda Co., and Mitsui Metal Mining Company, all of which hope to produce between 10 to 30 tons a month.

Toho Titanium expects to start producing next spring. Their output: 20 tons per month, increasing to 100 tons per month by the end of the year.

Japanese industries are using practically no titanium themselves. It is estimated that less than one ton found its way into research projects last year. And there will be no increase until titanium is cheaper than other metals based on imported alloying agents. Most observers think that this is probably a long way off.

AEC REPORTS

TO HELP INDUSTRY select non-secret reports of interest in the atomic energy program, the Atomic Energy Commission is compiling a new bibliography series. The first publication—Metallurgy and Ceramics—appeared last month.

In it are listed or abstracted 239 technical reports, culled from the 9,000 that AEC has released since 1947. Free copies are available on request from the Industrial Information Branch, United States Atomic Energy Commission, Washington 25, D. C.

Other bibliographies of past reports that will be issued in the near future: Chemistry and Chemical Engineering, Construction and Civil Engineering, Electronics and Electrical Engineering, Health and Safety, Industrial Management, Mechanics and Mechanical Engineering, Mining and Geology, and Nuclear Technology.

Future reports will be announced as they are released in a special section of Nuclear Science Abstracts, a publication issued twice monthly by AEC, which is available on a subscription basis ($6.00 per year).

WESTINGHOUSE'S Robertson

GENERAL ELECTRIC'S Cordiner

DUMONT'S Dumont

CARRYING INDUSTRY'S MESSAGE

THE THREE MEN PICTURED ABOVE represent competing companies, but last month they stepped to a podium at Rensselaer Polytechnic Institute to join forces with other leaders of the electrical manufacturing industry. The joint mission: to predict where the industry was going and to explain its role in the present economy to 600 high school teachers of social studies, who had come to the Troy school from all over the United States.

The occasion was the third session of the Industrial Council—organized by RPI and paid for by industry. (The first session, held in spring of 1952, dealt with the oil industry; the second, in the spring of 1953, covered the chemical industry). The two-day session reached this conclusion: the electrical industry has just scratched the surface of employment, sales and scientific progress.

Don G. Mitchell, Chairman, Sylvania Electric Products, Inc., related the phenomenal growth of the industry: ten-fold increase in power generation from 1920 to 1952; employment up from 1910's 90,000 to 1952's 900,000; salaries and wages, in 1910, amounted to less than $50,000,000—today the figure exceeds three billion.

Television expert and president of the company bearing his name, Dr. Allen B. Dumont, predicted that 50 million television sets will be in operation within five years. However, he added, the swing to color will be slow, limited by the estimated high costs of color receivers.

Power generation has doubled every ten years since 1910, and 1950's output will be doubled by 1960, Andrew W. Robertson, finance chairman of Westinghouse Electric Corporation, told the teachers.

General Electric's president, Ralph G. Cordiner, detailed how the electric utility business is expanding. Private utilities, he declared, are spending $20 billion in the 10 post-war years.

Main purpose of the Industrial Council is to foster understanding and goodwill between the public and industry. The approach: key reports by top executives on how the industry began, how it operates, its own conceptions of its responsibilities, what it has achieved and where it is going. These reports are given at mealtime gatherings when all delegates are present. Then the session is divided into a number of simultaneous panels during which searching questions are asked. In the three conferences held so far, the teachers have quizzed the executives more freely than those who attend stockholders meetings.

RPI hopes to cover 12 different industries with the program. After that, it may be necessary to enlarge the scope.

NEWS BRIEFS

• National Science Foundation has announced 123 awards totaling $1,332,000 for the support of basic research. First grants made in fiscal 1954, they are distributed among scientists from 34 states, the District of Columbia, Puerto Rico and England.

• Research activity of New York University's College of Engineering increased 14 percent during the last year as annual expenditure for sponsored research reached $2,017,000, compared with $1,758,000 the previous year.

• Atomic Energy Commission has approved a proposal made by Newport News Shipbuilding and Dry Dock Company for a special study of the application of nuclear power to the propulsion of ships. All costs will be borne by the company. The contract will run for one year, after which AEC will receive a complete report.

• National Lumber Manufacturer's Association is planning a million dollar research program to develop new and better wood products.

• A New Rochelle (N. Y.) firm—Sightmaster Corporation—has started converting conventional black and white TV sets to receive compatible color telecasts. The operation involves: (1) boosting set voltage, (2) changing essential circuits, (3) adding a chrome section and (4) inserting a 15 in. color picture tube—biggest currently available. Cost of conversion: about $250.

SCIENTISTS VINDICATE NBS

WASHINGTON—For the first time since last March, government scientists are breathing easier. The reason: An independent committee of nationally-known scientists and engineers has publicly vindicated the performance of the National Bureau of Standards in the bitter "battery additive controversy" (*Product Engineering*, May 1953, p. 137). The group's report was a stinging rebuke for those who would permit political expediency to overrule opinions drawn from standard scientific tests in a dispute about the engineering performance of a product.

Two major sections of the committee's study ended the argumentative phases of the affair: 1) The group found that AD-X2, manufactured by Pioneers, Inc., was "without merit" as a battery additive; and 2) exhaustive scrutiny showed that NBS-conducted tests, which reported the compound to be ineffective, were excellent.

The Details

In the report, the committee, appointed by the National Academy of Sciences, stated:

- "From the study and investigation, the committee concluded that the quality of the work of the National Bureau of Standards in the field of lead acid storage battery testing is excellent."
- "That while Pioneers, Inc. claim that AD-X2 has substantial merit, the relevant data now available to the committee on the effects of AD-X2 are adequate to support the position of the Bureau of Standards that the material is without merit."
- "We find no data obtained from any well-designed scientific experiment which is inconsistent with the hypothesis that AD-X2 behaves like a corresponding mixture of sodium and magnesium sulfates and is substantially neutral in its effect upon a lead storage battery".

These conclusions by impartial observers added up to a sharp criticism of Commerce Secretary Sinclair Weeks and former Assistant Secretary Craig R. Shaeffer who handled most phases of the dispute.

How it Started

The controversy flared up last March when Weeks, acting on Shaeffer's recommendations, demanded that NBS Director Allen V. Astin resign because the Bureau "had not been objective" in examining AD-X2. The Secretary even went to the Post Office Department and asked that a fraud order issued against the manufacturer of the additive be withdrawn because it was based on NBS findings. When a storm of protest from scientific circles broke over such conduct and accusations by the Secretary of Commerce, Weeks asked Detlev W. Bronk, president of the National Academy of Sciences, to form a committee to evaluate the work done by NBS on the additive.

Observers in Washington have been predicting the exoneration of NBS ever since last August. At that time Weeks suddenly did an about face and requested Dr. Astin to stay on at the Bureau. Shortly after, assistant Secretary Shaeffer suddenly resigned.

However, despite the favorable report, it is more than likely that bitterness arising from the AD-X2 dispute will remain to haunt Washington for some time to come.

Undeserved Reorganization

Secretary Weeks used the AD-X2 affair as an excuse to attack the competency of Bureau personnel and to force a reorganization of NBS (*Product Engineering*, Sept. 1953, p. 198). The organizational changes are still in effect.

One rather significant change places the right to make decisions about product testing in the hands of the Secretary instead of the Director. That means a non-technical person decides whether the Bureau should test a product, evaluates the report, and determines whether to make the report public (previously, all tests conducted by NBS were considered in the public domain).

Representatives of industry have protested that the new procedure removes fraud protection they have been able to rely on, and invites a repetition of the battery additive mess. They point to Weeks' conduct in the AD-X2 dispute as proof that a non-technical person is not competent to make such decisions.

In another change, NBS was stripped of its defense research projects and the major share of the funds that buy facilities and pay salaries. Four major sections were transferred to jurisdiction of the Defense Department. This action was so precipitate that the Defense Department still has no place to house the groups and therefore, they have had to remain in NBS facilities.

The net effect of the program was to smash morale of Bureau employees, to chase veteran scientists out of government service, and to disrupt urgent research programs at a time when the nation can ill-afford it.

Another Report

One suggestion as to how Weeks can make up for all this is documented in the Kelly Committee Report, also just released last month. This group, composed of representatives from various technical societies, studied the organization of NBS. Their findings praised NBS personnel and included these recommendations for improvement:

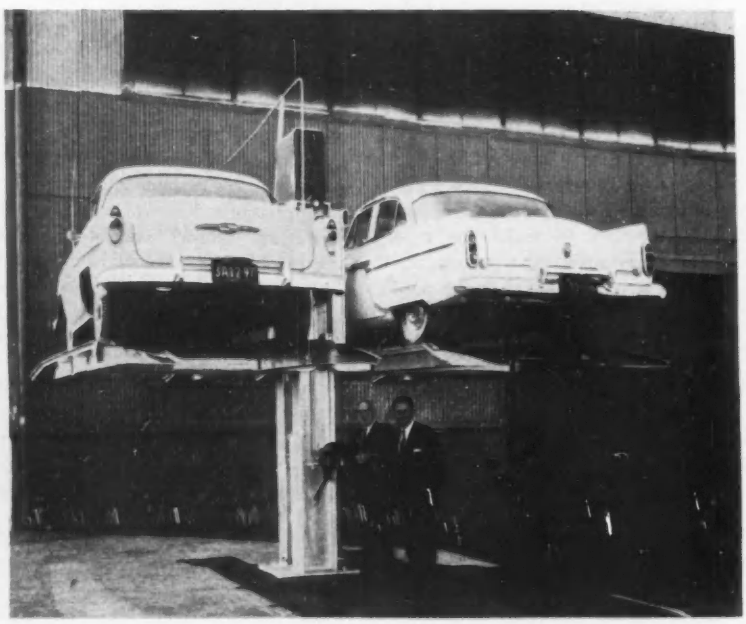
- A higher level of activity in the basic programs.
- Modernization of facilities and increased space for basic programs.
- Continued and increased use of the Bureau by other agencies of government (including the Department of Defense and Atomic Energy Commission) in indicated areas of science and technology.
- Increased support of standard samples program.

The first step in accomplishing any of such recommendations is to obtain an adequate appropriation for NBS. In fiscal 1954, the Bureau suffered a whopping 26 percent slash in direct appropriations. This cut was so severe that many industry associations, who rely on NBS standards, have voiced the fear that the agency can no longer carry out its assigned mission. Several groups are currently investigating means of accomplishing this.

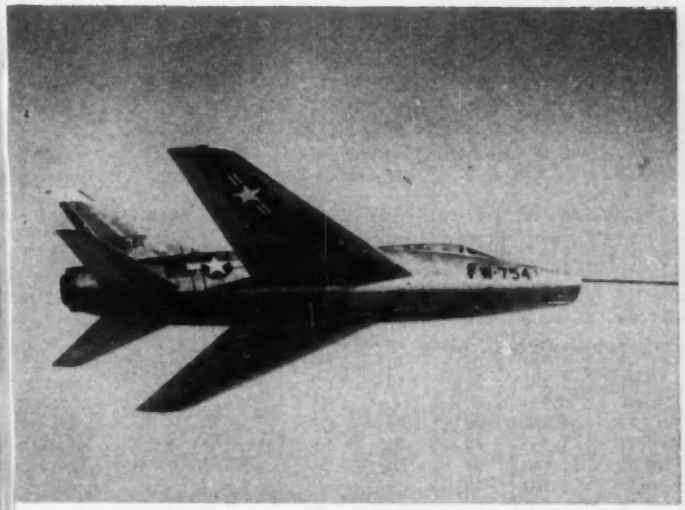
One other effect lingers from the AD-X2 affair. Many government agencies, also charged with product testing, are still chary about condemning a commercial product, no matter how strong the scientific evidence appears. It is an unfortunate atmosphere that may take several years to correct.

THE NEWS IN PICTURES

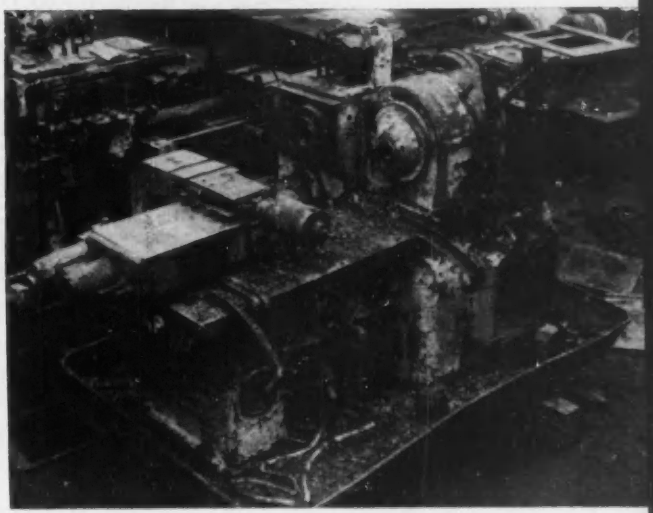
FIRST SIDE-BY-SIDE military trainer goes through its paces at Pensacola (Fla.) Naval Air Station where the Navy is evaluating this new idea in fledgling pilot instruction. Designed and built by the Ryan Aeronautical Company, "Model 72" permits direct communication between student and instructor, supplies improved visibility for the instructor, and eliminates duplicate instrumentation. Training tandem-style evolved from the design of the Wright Brothers' first successful craft—because of the long thin fuselage, the student had to sit either fore or aft of the instructor. Such an arrangement has prevailed in military trainers for 40 years, until Ryan came up with this approach, in which the commercial Navion is redesigned to military standards.



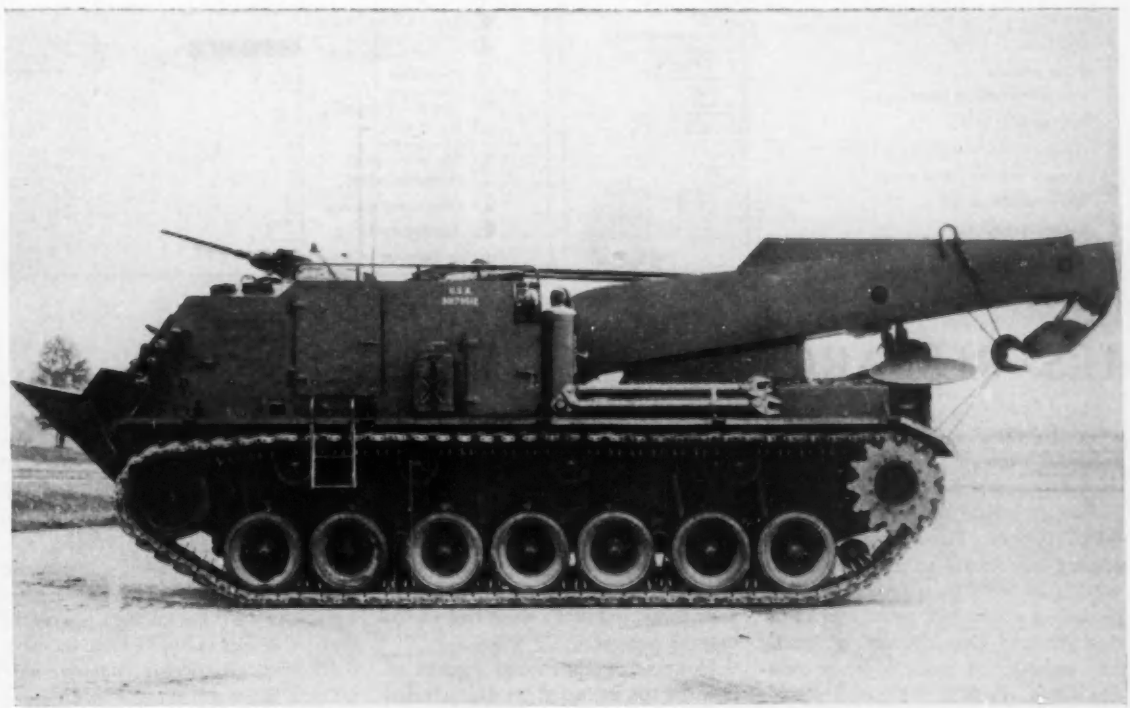
HYDRAULIC push-button-operated Sky-Park is designed to increase capacity of crowded city parking lots by introducing vertical double parking. Designed by Charles A. Simmons of Simmons Machine Tool Corporation, the device, anchored in a concrete base, lifts two cars to a height of about six feet and holds them there indefinitely. Two additional cars can be parked underneath.



NEW SUPERSONIC FIGHTER, North American's F-100 Super Saber, incorporates a razor thin, 45 deg swept back wing and tail. Blunt-nosed craft is powered by a Pratt and Whitney J-57-7 turbojet engine with afterburner. Other features: widespread use of titanium, automatically regulated air conditioning and pressurizing system, one-piece clamshell canopy, and drag chute landing installation to shorten ground roll.



WRECKAGE of precision hydraulic automatic lathe, built by Gisholt Machine Company, after it was dragged from wreckage of General Motors fire-gutted Detroit Transmission Works. Fire that did over $40 million damage generated so much heat that oil burned out of headstock of this machine, bearings and other hardened surfaces were annealed and electric control circuits fused together. This lathe was cut up for scrap.

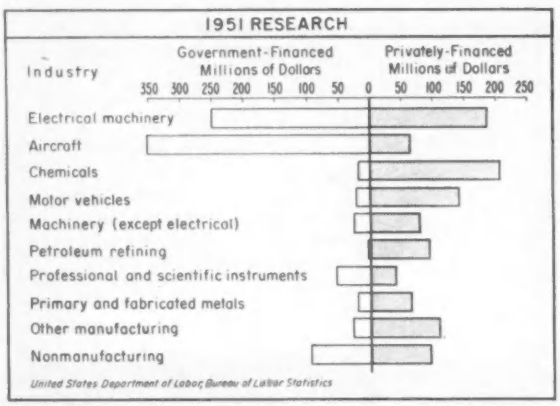


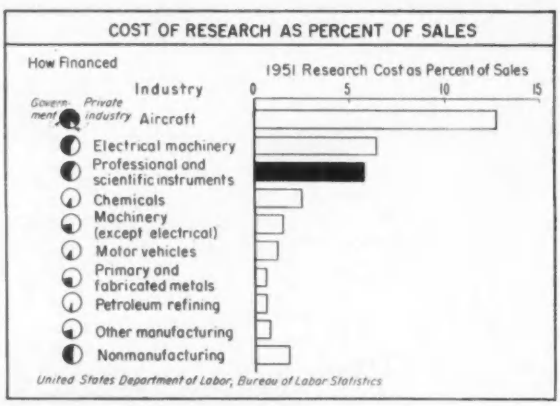
HEAVILY ARMORED tank retriever, the T-51, will go into production this summer at Chrysler's Detroit Tank Plant. The company will try to put the vehicle into production with only eight months lead time—shortest ever allotted for such equipment. Chrysler estimates that 2,400 people will be employed at the plant to complete the $48 million contract for retrievers. This represents a cut of 1,000 from present conditions since 3,400 employees are now completing Chryslers M-47 medium tank contract. The company plans to keep all 2,400 on the payroll while they are tooling up for the new vehicle.

U. S. Research and Development Expenditures
(millions of dollars)

Year	Total research expenditures	Government				Industry				Colleges and Universities			
		Research expenditures		Cost of research performed		Research expenditures		Cost of research performed		Research expenditures		Cost of research performed	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1941	$900	$370	41	$200	22	$510	57	$660	73	$20	2	$40	5
1942	1,070	490	46	240	22	560	52	780	73	20	2	50	5
1943	1,210	780	64	300	25	410	34	850	70	20	2	60	5
1944	1,380	940	68	390	28	420	30	910	66	20	2	80	6
1945	1,520	1,070	70	430	28	430	28	990	65	20	2	100	7
1946	1,780	910	51	470	26	840	47	1,190	67	30	2	120	7
1947	2,260	1,160	51	520	23	1,050	47	1,570	69	50	2	170	8
1948	2,610	1,390	53	570	22	1,150	44	1,820	70	70	3	220	8
1949	2,610	1,550	59	550	21	990	38	1,790	69	70	3	270	10
1950	2,870	1,610	56	570	20	1,180	41	1,980	69	80	3	320	11
1951	3,360	1,980	59	700	21	1,300	39	2,300	68	80	2	360	11
1952	3,750	2,240	60	800	21	1,430	38	2,530	68	80	2	420	11

Source: Research and Development Board, Department of Defense, April 1953.





U.S. RESEARCH

WASHINGTON—National expenditures for scientific and engineering research hit a new high in 1952—$3.75 billion, of which the government paid $2.24 billion. These figures, representing an increase of more than 300 percent in the past ten years, are included in a detailed study (Scientific Research and Development in American Industry: A Study of Manpower and Costs; Price $.50) just released by the U. S. Department of Labor and the Defense Department.

Most significant fact contained in the report is the trend to heavy government subsidation of research, primarily in military fields. In 1941, industry paid the major share of the nation's research bill—57 percent; the government's contribution was only 41 percent. By 1952, the tables had turned completely: government funds represented 60 percent of total expenditures; industry's share had slid to only 38 percent.

However, while federal support of research has increased greatly, government labs still perform the same percentage of work. The biggest gainer in this respect has been the academic institution. In 1941, colleges and universities completed about $40 million worth of research, five percent of the total; in 1952 the figure was over 10 times higher, $420 million, and the percentage had more than doubled to 11 percent.

In the report, detailed statistics are based on 1951 data, since the Department of Labor started their survey in mid-1952. For example, in an industry breakdown, electrical machinery builders led the field in 1951 with total research expenditures; aircraft companies were close behind. Government support was responsible. Leaders in privately-financed research: chemical and motor vehicle industries.

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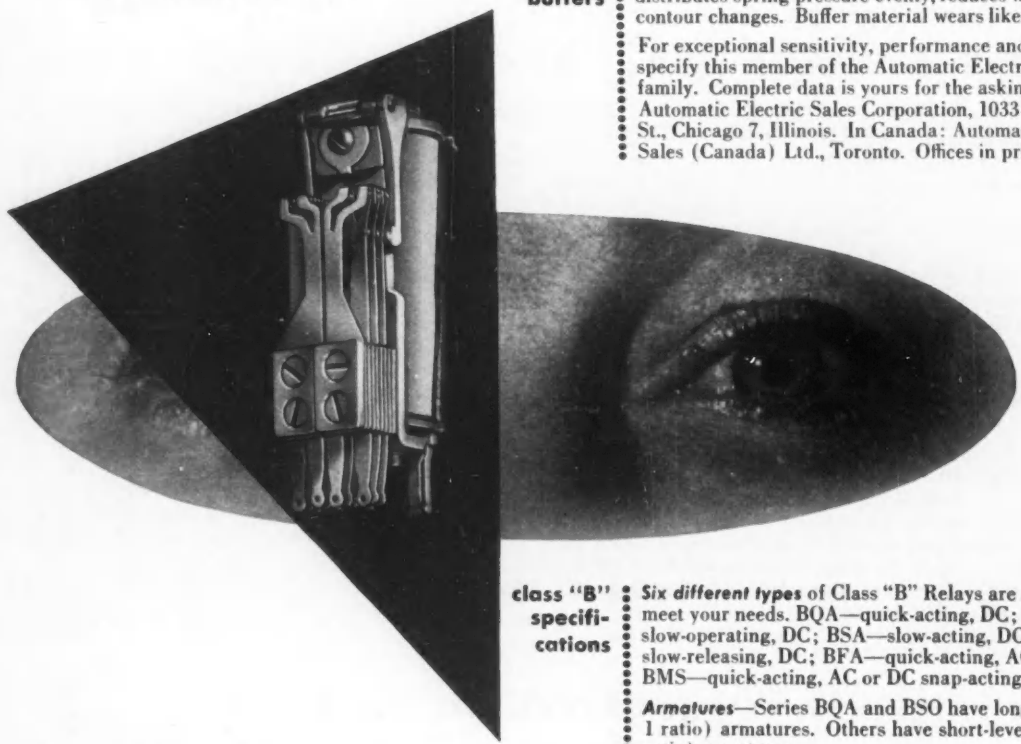

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advanced features — This Class "B" Relay meets stresses at critical areas . . . the stresses and strains of hundreds of millions of operations . . . with advanced features that are standard equipment.

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Contact spring capacity—Series BQA, BSO and BFA, 13 springs per pile-up. Series BSR and BSA, 6 or more springs per pile-up. Series BMS, 1 or 2 snap-action switches.

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For more detailed information, ask for Circular 1801.

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An Analog Circuit Ratio Chart

C. H. McADIE
Electronics Division
Westinghouse Electric Corporation

THE USE OF ANALOGS makes it possible to set up circuits for which the actual component values are not available. Also measurements are possible for complicated circuits that would be difficult to calculate, or for circuits that would require high power or high voltage. The chart, Fig. 1, is designed to help obtain desirable analog ratios and can be extended where needed by the simultaneous solution of the equations listed above the curves.

Analog component values are obtained by multiplying the desired impedances and resistances by a constant called the impedance base, K_z, and by dividing all impedances, but not the resistance, by another constant called the time base, K_t. K_z effectively divides the analog current; K_t does not affect the value of current but does multiply the frequency applied to the analog as compared to the original circuit. The applied voltage can also be divided by a constant K_v to bring the analog voltage to any desired level. This voltage constant affects the current, and divides it in proportion to the voltage.

When a component of a certain value is not available it can be simulated in an analog circuit by either changing the frequency base K_t or the impedance base K_z, or both. For example, suppose that an inductance of ¼ henry is desired but is not available. However, a one henry choke is available. Thus, letting component values for the circuit be described by primed symbols: $L' = 1$, and $L = \frac{1}{4}$.

Also,

$$L' = L\,\frac{K_z}{K_t},$$

and

$$\frac{K_z}{K_t} = \frac{1}{1/4} = 4$$

Suppose also that the desired capacitor is available so that

$$C' = C, \text{ or } \frac{C'}{C} = 1 = K_z K_t$$

Referring to the chart, and going from the intersection of $K_z/K_t = 4$ and $K_z K_t = 1$ lines, values of K_t and K_z are 0.5 and 2.0, respectively. Thus, to simulate the effect of a 0.25 henry choke, all resistances in the actual circuit must be multiplied by four before putting them in the analog circuit and a frequency of one half that of the actual circuit frequency should be used.

Constant K_v can be chosen to be of any value, resulting in an available analog voltage E'. Measurements now can be made in the analog circuit of transient or steady-state values of current and voltage at the points desired. The currents observed must be multiplied by $K_z K_v$ and the voltages by K_v to obtain the actual circuit currents and voltages from those observed in the analog.

As another example, consider a power supply filter circuit which has a keyed load. This will naturally give rise to voltage transients which can be measured. Assume the desired components are as shown in Fig. 2.

If only a four henry choke and a four μf capacitor are available, the analog constants can be determined from the equations given on the chart.

$$L' = 4 = 1 \times \frac{K_z}{K_t};\ \text{therefore,}\ \frac{K_z}{K_t} = 4$$

$$C' = 4 = \frac{12}{K_z K_t};\ \text{therefore,}\ K_z K_t = 3$$

From Fig. 1, it can be seen that $K_z = 3.5$ and $K_t = 0.86$. Using these values, the analog resistances and keyer frequencies necessary to simulate the transient of the desired circuit can be found:

$$R' = (R)\ (K_z) = (10\ K)\ (4) = 40\ K$$
$$R_1' = (R_1)\ (K_z) = (1\ K)\ (4) = 4\ K$$
$$F' = (F)\ (K_t) = (10)\ (0.86) = 8.6$$
$$= (100)\ (0.86) = 86$$
(Keyer range cycles)

The analog circuit values are therefore as shown in Fig. 3.

In problems of this kind where the analog circuit is also intended to filter the ripple from a rectifier, some caution in the choice of analog values must be used. The LC product of the analog should not depart too much from that of the original circuit or the ripple may be greatly different and may distort the results. It should be noted that the LC product could be kept constant by maintaining K_t equal to unity.

Another important characteristic shown, Fig. 1, is that almost any set of L and C values in the analog can be used to simulate other values of the

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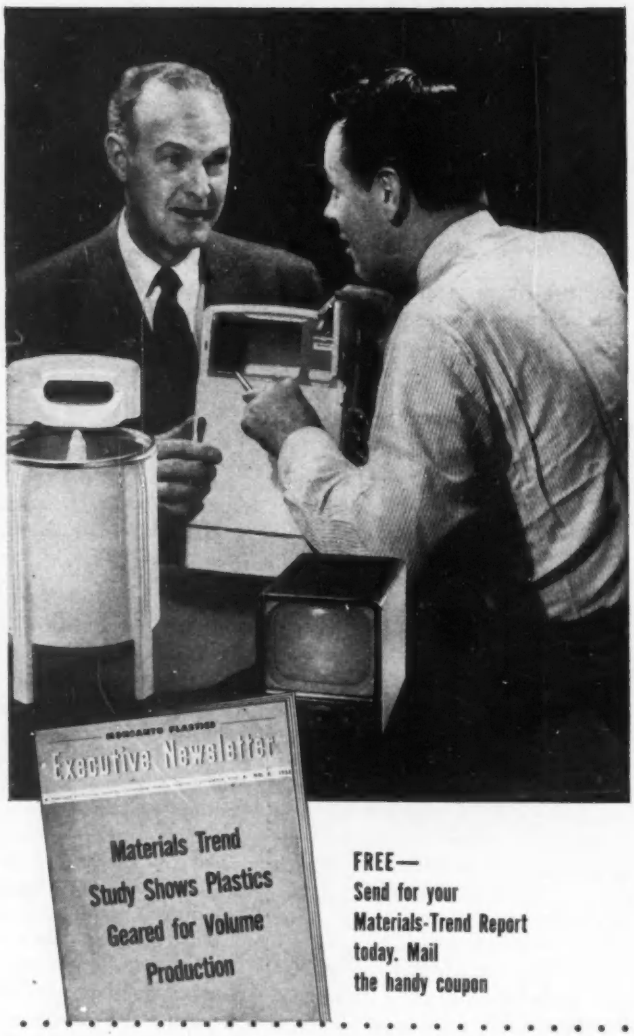

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An Analog Circuit Ratio Chart (continued)

L or C by merely changing the resistances and frequency. For example, suppose all the L's and C's have a value of unity and it is desired to find the effect of halving L.

$$L' = L\frac{K_z}{K_t}$$

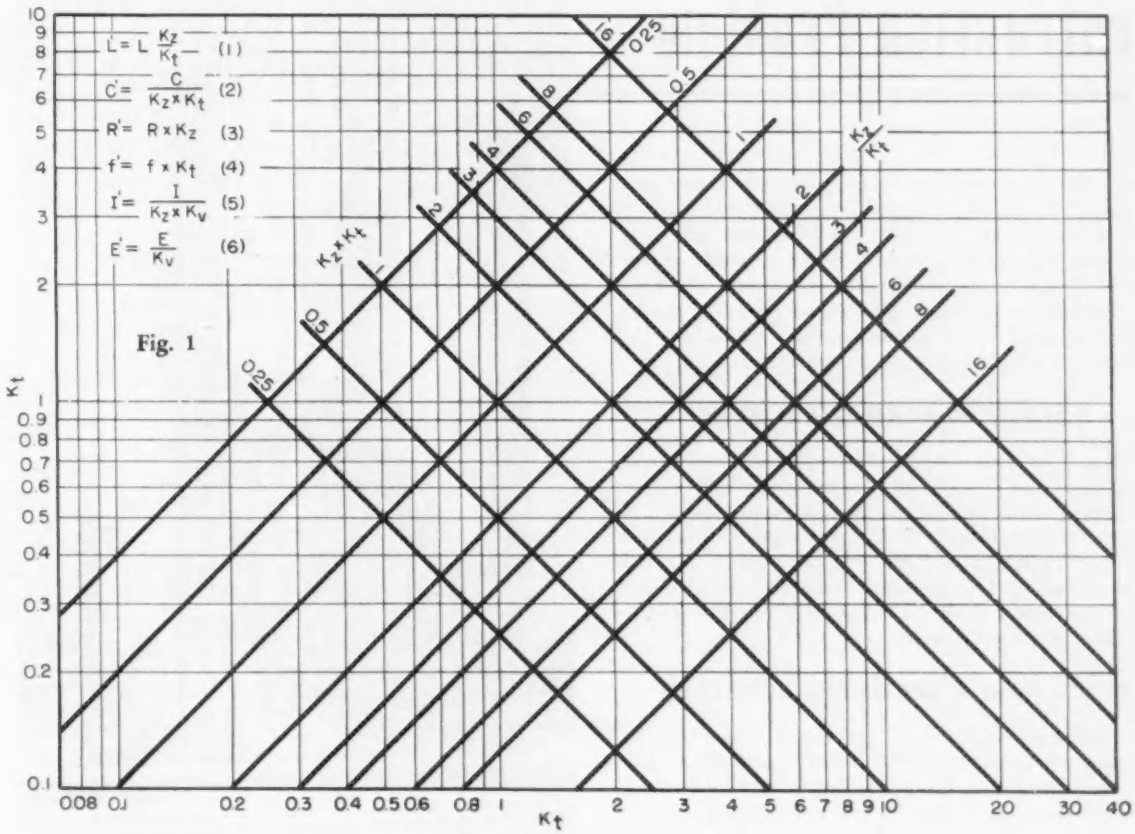
$$1 = \tfrac{1}{2}\frac{K_z}{K_t}; \quad \text{therefore,} \quad \frac{K_z}{K_t} = 2$$

$$C' = \frac{C}{K_z K_t}$$

$$1 = 1/K_z K_t \text{ and } K_z K_t = 1$$

From the chart, $K_z = 1.41$ and $K_t = 0.707$.

In other words, increasing the resistance by 41 percent and decreasing the frequency 70 percent, simulates dividing L by two. In most cases, changing resistances and frequencies is much easier than changing inductance and capacitance.



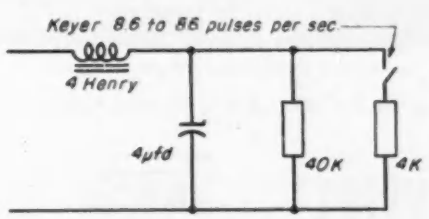


Fig. 2—Filter circuit with keyed load for dc supply. Desired values of components are shown.

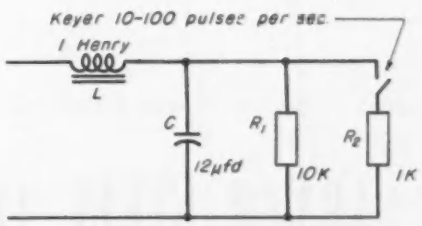


Fig. 3—Analog circuit which can be used in place of Fig. 2 if desired components are not available.

How Armco ALUMINIZED Steel Solved a Contraction Problem

Before this stack connected with a high-temperature fractionating column was sheltered by a rain-shield made of Armco ALUMINIZED* Steel, driving Gulf Coast rains were a serious hazard. The stack operated normally at 700 degrees F, but semi-tropical rains would cool the windward side down to 300 to 400 degrees F, while the lee side of the stack remained at operating temperature. Uneven contraction would cause the stack to bow.

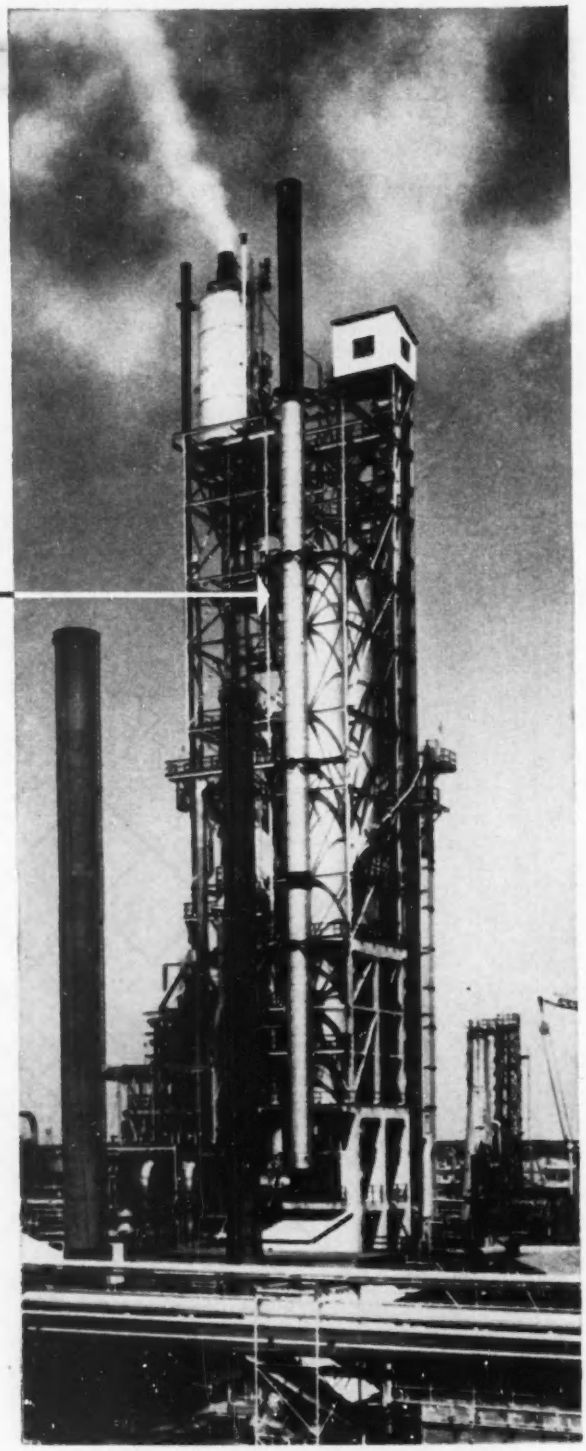
SOLVED CRACKING PROBLEM

Structural supports were rigid and would not permit much movement of the stack. Yet something had to give, so cracking of the stack was an ever-present threat. To protect the stack from failure, it was fitted with a shield of Armco ALUMINIZED Steel with an airspace between shield and stack. This protected the stack from wind and rain, prevented uneven contraction and solved a serious problem for the oil refinery.

HEAT- AND CORROSION-RESISTANT

Its combination of heat- and corrosion-resistance makes Armco ALUMINIZED Steel ideal for many applications like this. At temperatures up to 900 degrees F it is used for heat reflection; at higher temperatures it becomes an excellent radiator of heat.

For more information on this special aluminum-coated steel, phone the nearest Armco District Office or write us at the address below.



An Armco ALUMINIZED Steel raincoat for a stack

See our catalog in "Sweet's Product Design File" for information on the other Armco Special-Purpose Steels.

ARMCO STEEL CORPORATION

4903 CURTIS ST., MIDDLETOWN, O. • EXPORT: THE ARMCO INTERNATIONAL CORPORATION

ARMCO

*®U. S. PAT. OFF.

Calculator for *G* Loadings

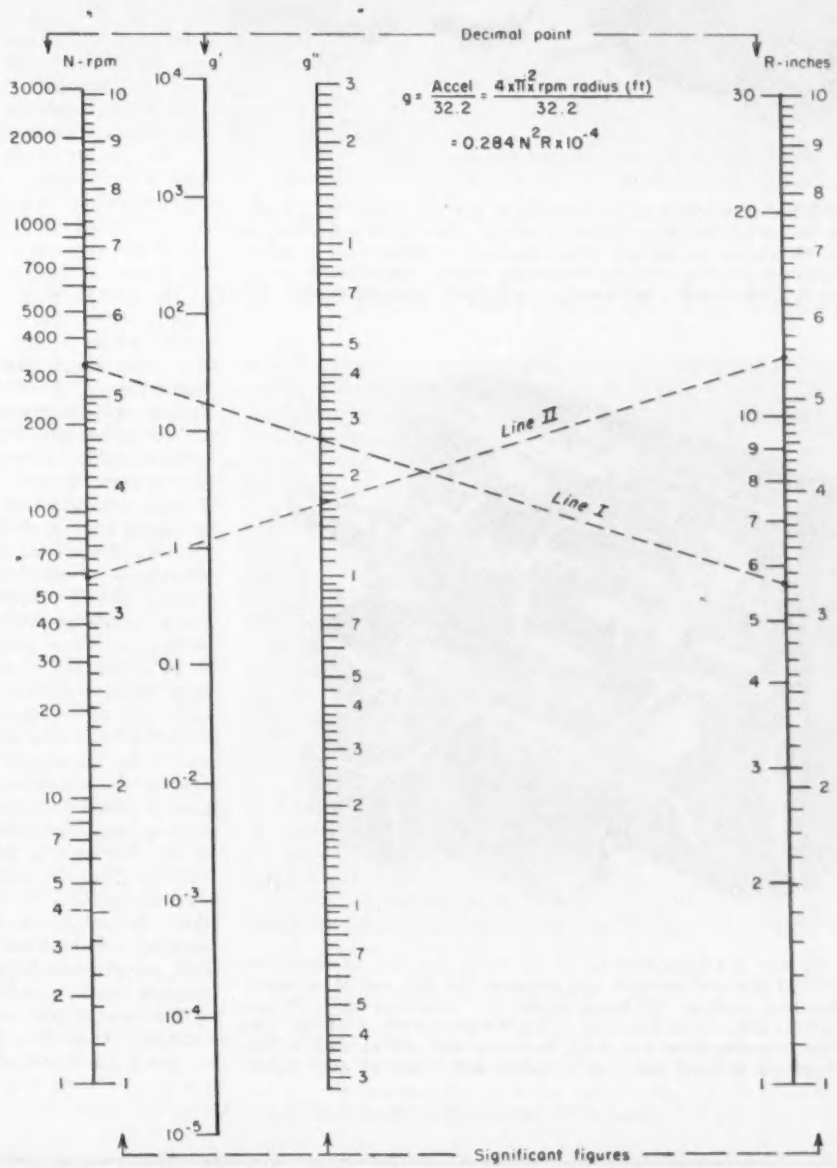
JOSEPH F. SODARO

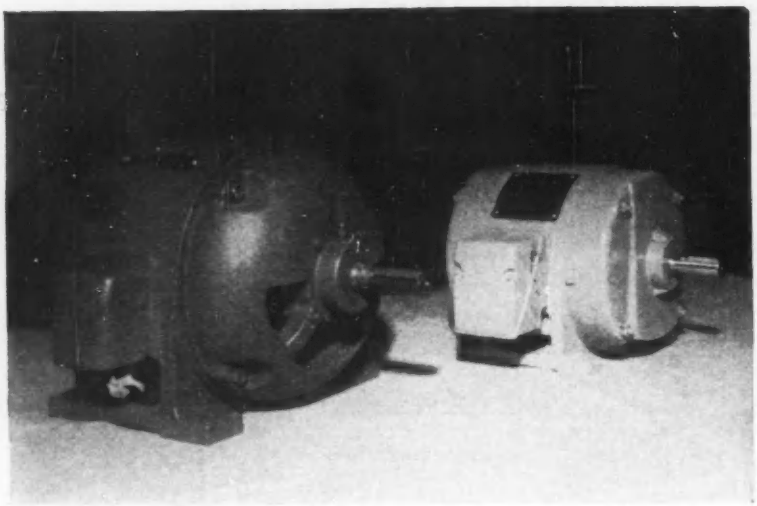
NORMAL ACCELERATION or g loading developed by a rotating body such as a centrifuge can be solved graphically with this nomograph. The equation given on the chart.

Two g scales are shown; the left-hand N and R scales are used with g' for decimal point determination, and the right-hand N *and* R scales with g'' for significant figures. This increases the range of the chart without reducing the overall accuracy.

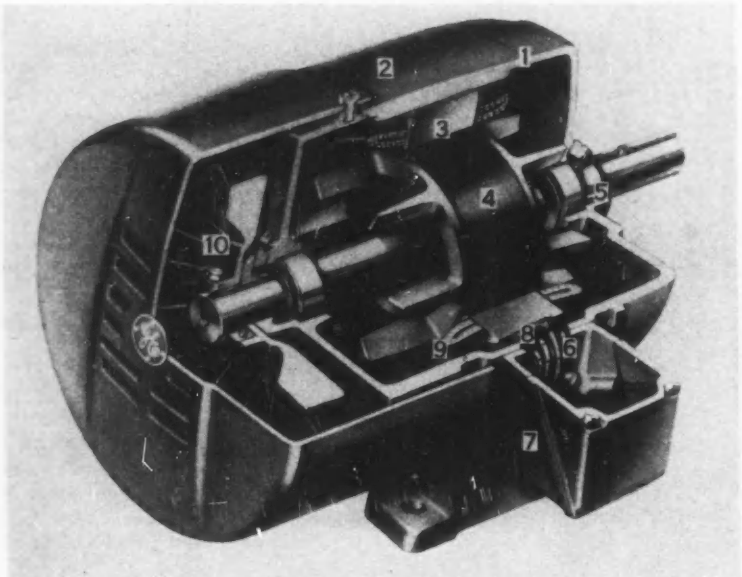
EXAMPLE: R=5.5 in.
N=325 rpm.

SOLUTION: Using left hand N and R scales Line 1 gives g between 10 and 100. With right hand scales, Line II gives g=16.5





HALF AS LARGE and as much as 40 percent lighter per horsepower than former models, this new line of a-c polyphase induction motors offers more protection and less maintenance. Shown are the old and new 1 hp motors. Other types of motors planned for in this new series include the following: vertical, single-phase; wound rotor; explosion-proof; multi-speed; face mounted; and flange mounted models.



FEATURES OF the new totally-enclosed fan-cooled motor are: (1) moisture-proof sealing compound; (2) cast-iron enclosed; (3) polyester film slot and phase insulation; (4) solid cast rotor windings; (5) labyrinth seal; (6) numbered leads; (7) easy access conduit box; (8) compression-tight seal; (9) water-proof stator windings; (10) split-hub plastic fan. In ratings from ½ to 30 hp, the new motors will be made in horizontal drip-proof, totally enclosed fan cooled models, and a line of gear motors.

Quieter, Better Protected Motors

Built to the latest NEMA frame dimensions, this new line of Tri-clad "55" motors has new concepts of motor designs that give an average size reduction of 50 percent by volume, and averaging 22 percent less weight per horsepower. Retaining the cast-iron construction, the new motors have a new insulation system, bearing assembly, and ventilation.

The feature of the insulation system is a new polyester film which is eight times as strong as previously used materials. It is used to insulate the phases and slot tubes in the stator, the points of hardest motor wear.

The new bearing assembly is more tightly sealed, and is lubricated by a grease which is said to last at least five times longer than formerly used lubricants. A double-end ventilation system cools the motor by drawing air in from beneath both end-shields, through baffled air passages, and out louvers on the sides of the frame. Larger integrally-cast rotor fans increase the cooling air flow through the motor and dissipate rotor heat more effectively. Protection has been increased by 60 percent on the drip-proof enclosure through new end-shield and frame design.

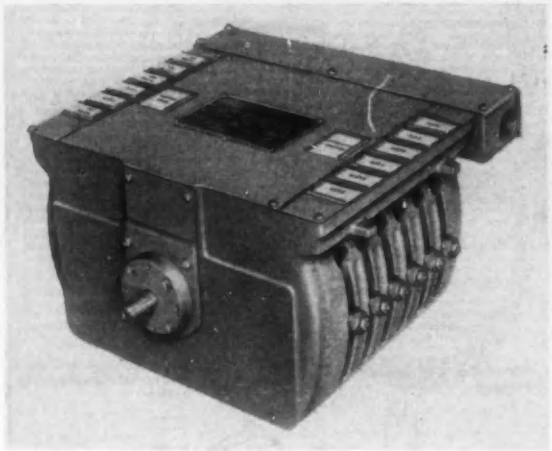
In an attempt to reduce the magnetic hum, which is caused by the radial pull of the rotating air-gap magnetic field, the rotor and stator punchings were redesigned. Spring-loading bearings and maintenance of closer tolerances between the outer race and the bearing housing reduce the bearing rattle. The new 10 hp motor is said to have about the same overall noise level as the old 2 hp motor. In addition, the new motor gives the extra damping effect of cast iron construction, reduced low-frequency vibrations through smaller panel sections.

The new motors will be available in ratings from ½ to 30 horse power in speeds from 600 to 3600 rpm.

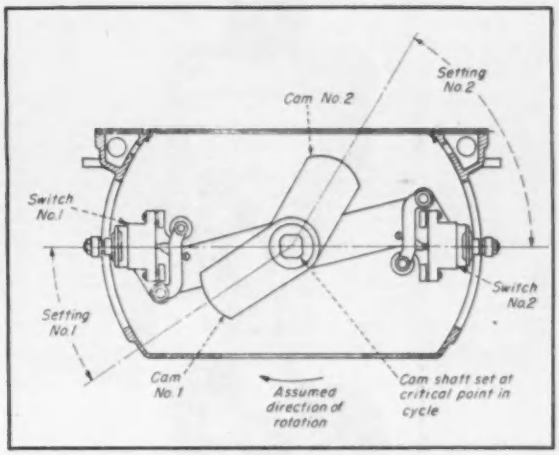
General Electric Co., 1 River Road, Schenectady 5, N. Y.

MATERIALS - PARTS

SPECIFIED BY PRODUCT ENGINEERS



THE ROTARY CAM LIMIT SWITCH features external adjustment of cams during the operation of the equipment. Adjustment is made by setting the thumbscrews on the side of the switch.



CONSECUTIVE CAMS operate snap switches at opposite sides of the housing. The external adjustment can be made over a full 30 deg of cycle. Dust resistant covers can be swung open.

Rotary Cam Limit Switch Adjustable In Operation

Fine adjustment of each cam in this rotary cam limit switch can be made by changing the setting of the thumbscrew on the outside of the housing during the operation of the equipment. This provision simplifies the synchronizing of the press cycle of independently powered press auxiliaries, since the press can be stroked while individual switches are being adjusted. The large diameter swept by the cam faces offers an added factor of adjustment sensitivity. At the point of adjustment of the thumbscrew, one degree is equivalent to about $\frac{1}{8}$ in. of adjustment.

Double break snap switches are used for added safety and to permit more accurate timing at the moment of contact. Circuits may be wired so that the "make" and "break" can be timed independently. In this way the circuit to be controlled can be closed from a fraction of a second to nearly a complete press cycle, and at any interval in the press stroke. The switch operates equally well in either direction of rotation.

Two sizes of the limit switches are available. The smaller holds up to 12 cams, the larger up to 22 cams. A built-in zero speed switch is optional that will stop the main equipment should there be mechanical failure of the drive to the switch. This will prevent possible damage to the equipment by out-of-cycle operation. Card holders on the housing identify each cam circuit.

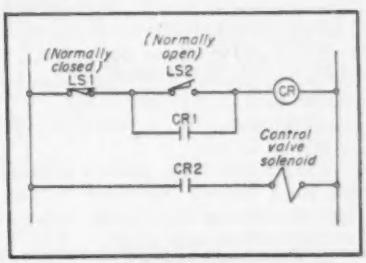
The cam shaft has sealed ball bearings at both ends, and no lubrication is required. The steel cams are chrome plated. The switch arms and follower arms are bronze and all hardware and steel components are cadmium plated.

In order to give accurate timing of either the making or breaking of a circuit, 10 deg. (momentary action) cams are used as standard equipment. This type of cam is suitable for use up to 60 rpm. Where timing of both the make and break of a circuit are important, the use of two cams wired as shown in the diagram at right gives the most accurate and flexible adjustment. The normally open cam LS-2 closes the circuit, energizing the control relay CR, which in turn holds the circuit closed. The normally closed LE-1 breaks the circuit.

The overall measurement of the 22 cam housing is 25 in., and $18\frac{3}{4}$ in. for the 12 cam housing. Width is $14\frac{7}{8}$ in. and thickness $8\frac{1}{2}$ in. for both.

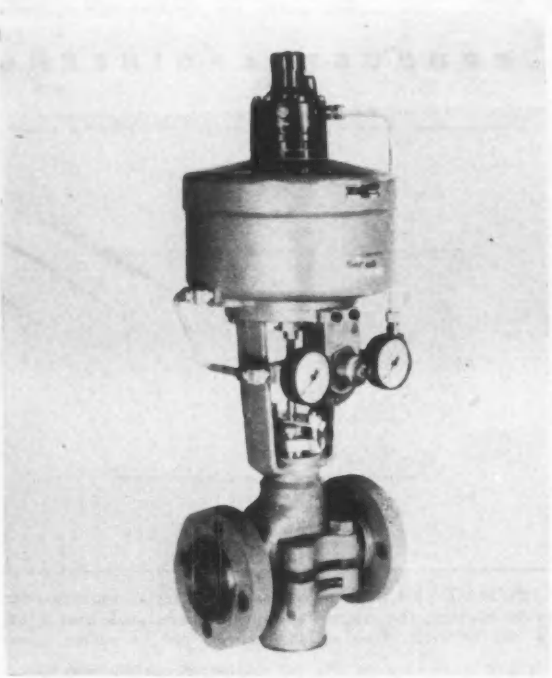
Danly Machine Specialties, Inc., 2100 S. Laramie Ave., Chicago 50, Ill.

THE ROTARY LIMIT SWITCH is mounted flush with the side of the press.

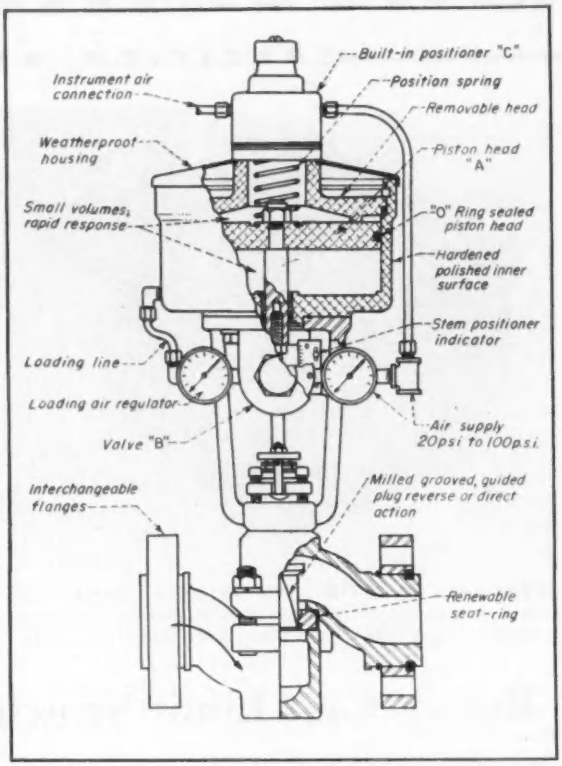


A TWO CAM CIRCUIT. The normally open cam LS_2 closes the circuit. The normally closed LS_1 breaks the circuit.

CONTINUED ON PAGE 216



SINGLE-SEATED, split-body construction allows use of a renewable and reversible seat-ring, held between the two halves of the body. No screwed or threaded insertions to corrode.



Single Seat, Split Body Valve Has Positive Control

Combining a new single seated, split body valve design with a new idea in valve topworks, this line of control valves known as the LB series offers the advantage of accurate, sensitive and positive control of hard-to-handle fluids used in the process industries.

The topwork consists essentially of an aluminum cylinder with bored and honed internals, a plastic piston with graphite impregnated O ring seal, and an integral positioning device that permits the static or cushion loading pressure to be in either the upper or lower cylinder chamber. Coupled with the reversible Conoplug made by this company, it permits any possible combination of forces to handle unbalanced loads, and/or requirements for predetermined plug positions on loss of operating air pressures. The operator is capable of positioning accurately to cover one part in 1,000 of instrument output span.

The cylinder Conomotor operates by varying the differential air pressure across a piston head "A". The under side of the piston is pressurized by a cushion-loading reducing-relief valve "B", to some suitable air pressure ranging from 5 to 10 psi.

The top side of the piston is automatically loaded through the force balance positioner "C" to any pressure up to 100 psi required to hold the stem position dictated by the primary control instrument.

In the built-in positioner "C", instrument air pressure exerts an upward force on the large center diaphragm of the positioner. Because of the difference in diaphragm areas, this force, plus the upward force of the main spring, is balanced by the downward force of the suppression spring. In balance, a small pilot flow provides instant response to the slightest change in control instrument air pressure.

An increase in control instrument air pressure temporarily raises the diaphragm assembly, closes off the exhaust and opens the inlet pilot valve. The increase in valve pressure moves the cylinder Conomotor piston downward, reducing the force on the range spring. This spring is not a power spring to reposition valve stem. When the valve stem is in the position dictated by the control instrument air pressure, the forces are again in balance.

This new valve series is presently available in sizes up to and including 4 in., and for series 15, 30 and 60 body ratings. The LB series valve bodies are available as standard in carbon steel, bronze, aluminum, 316 stainless steel, Hastelloy and Durimet plus some semi-standard alloys. Angle type bodies are available as well as straight through designs.

A simplified body construction permits use of replaceable, interchangeable line flanges of 150 lb, 300 lb, or 600 lb rating, on 600 lb ASA body using split-ring holding device similar to Van Stone joints. This eliminates need for stocking more than one weight body for any service up to 600 pounds. Teflon packing is used for high temperatures.

Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.

CONTINUED ON PAGE 218

Never

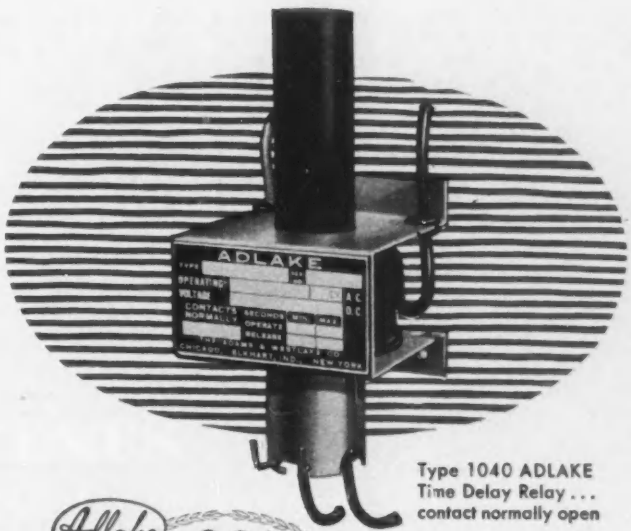
any Maintenance required with Adlake Mercury Relays!

Yes, thanks to their positive, leak-proof sealing . . . their sure-fire mercury-to-mercury contact . . . their immunity to normal vibrations and temperature changes . . . thousands of satisfied users in every branch of industry can testify that ADLAKE Relays literally require no maintenance whatever!

ADLAKE Relays have won their place by *proven dependability*—year in and year out—in jobs that conventional relays can do in an uncertain manner at best! For every ADLAKE Relay is tested—and guaranteed—to meet specifications!

Yes, in chick incubators or diesel locomotives—wherever sensitivity and dependability are required—you can always count on ADLAKE! Send for complete Relay catalog today . . . write The Adams & Westlake Company, 1169 N. Michigan, Elkhart, Indiana. In Canada, write Powerlite Devices, Ltd., Toronto.

Every ADLAKE Relay is tested... *and guaranteed*...to meet specifications!



Type 1040 ADLAKE Time Delay Relay . . . contact normally open

Adlake 96th year of serving the transportation and building industries

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

Voltage Regulator Assembly Has Two Units in One

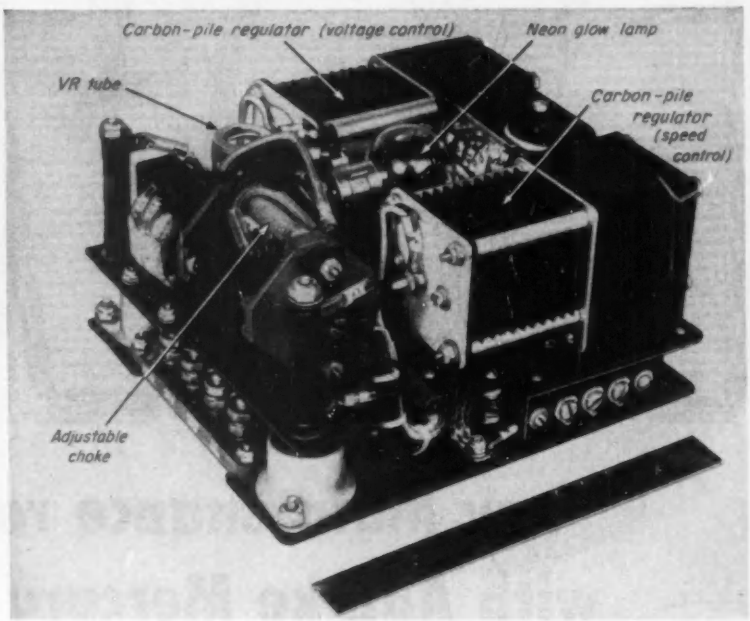
Designed in conjunction with new 1500 and 2500 va aircraft inverters, this FRS voltage regulator assembly combines into one unit the functions formerly performed by two separate units, the speed governor and the voltage regulator. The unit occupies no more space than required formerly by the voltage regulator, and the approximate dimensions are 5½ by 6¼ by 3¼ inches. Weight of the regulator is 4½ pounds.

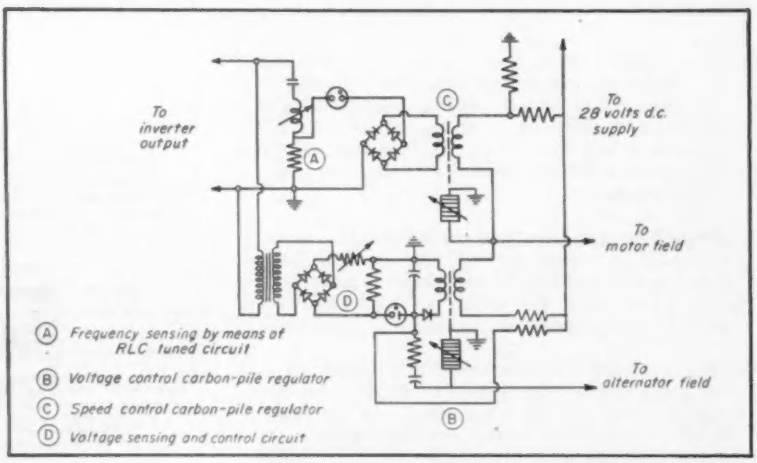
Features of the new control include: Instantaneous operation with no warmup required, made possible by the elmination of heater type vacuum tubes; voltage regulation better than ±5 percent and frequency regulation better than ±2.5 percent when the inverter is subjected to the environmental and test conditions of specification AN-I-10b; no decrease of efficiency or rating (compared to the former two-unit control) because field power is still supplied by a d-c source.

The frequency regulator circuit is a simple L-C series resonant circuit in which the voltage drop across a resistor is regulated to maintain frequency. The voltage is impressed on a series circuit which consists of a neon glow lamp, a rectifier, and the main coil of the 45 w carbon pile amplifier. Adjustment of the frequency is done with a variable choke. Overall frequency regulation possible with this circuit is on the order of ±10 cps (400 cps nominal).

The sensing element in the voltage regulator circuit is a VR tube. Initial build-up is accomplished by excitation from the d-c source through a resistor. The VR tube acts to vary the resistor drop, thereby controlling main coil excitation.

Jack & Heintz, Inc., 17600 Broadway Ave., Cleveland 1, Ohio




To inverter output
To 28 volts d.c. supply
To motor field
To alternator field
A Frequency sensing by means of RLC tuned circuit
B Voltage control carbon-pile regulator
C Speed control carbon-pile regulator
D Voltage sensing and control circuit

INSULATING MATERIAL made of fine, blown glass fibers is finding specific application where an efficient thermal and acoustical insulation is needed with minimum weight requirements. It is furnished in a variety of thicknesses, densities, and roll thicknesses. The material is fire resistant, will not mold or decay, and is efficient in dampening and absorbing sound in the middle and high range frequencies. The insulation is also light weight, dimensionally stable, and can be used on surface temperatures from sub-zero to 450 F. Gustin-Bacon Mfg. Co., 210 W. 10th St., Kansas City, Mo.

A NON-FLAMMABLE HYDRAULIC FLUID combining maximum fire resistance with hydraulic efficiency is said to satisfy the need for a safe, non-toxic, non-corrosive liquid that can be used in hydraulic equipment operated near open flames or adjacent to extreme heat conditions. Besides having good lubricating qualities, the fluid will not freeze, and is easily pumpable at temperatures down to 0 F. It has a viscosity index of 150, and can be used efficiently at 1,000 psi pump pressure. It will not attack synthetic rubber packings. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

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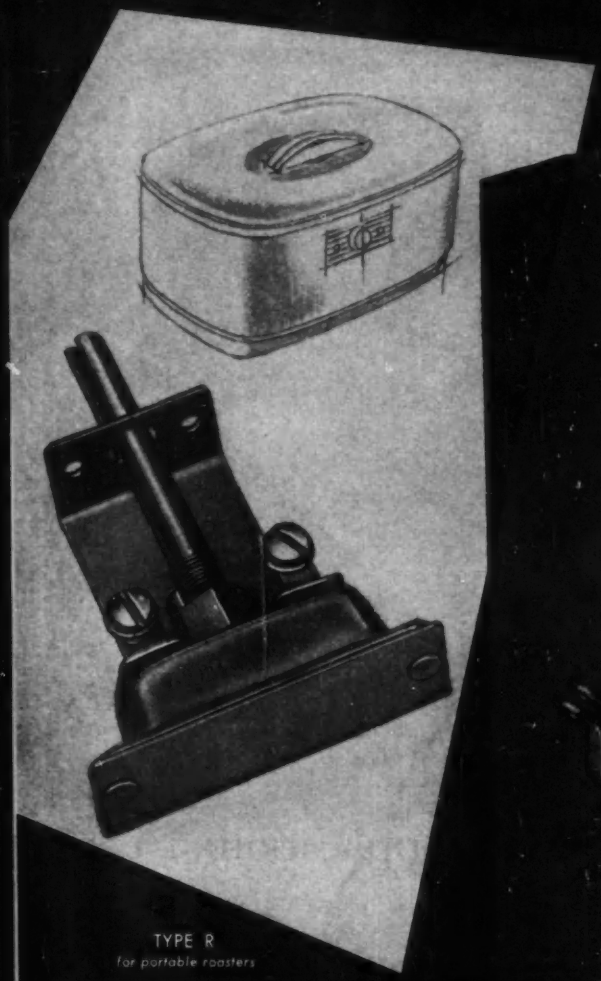
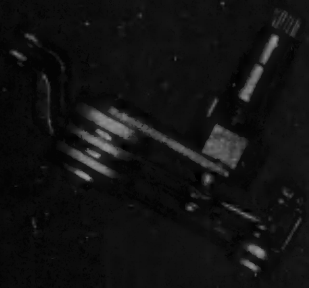


TYPE R
for portable roasters



TYPE SA
for automatic percolators

TYPE S
for steam or dry irons with multiple heats

THERMOSTATS

to whet a designer's imagination . . .

With competitive conditions ahead, you're probably reappraising your product. Or designing a new one. Either way, with Stemco thermostats on the job, there's every chance you'll improve performance . . . solve production headaches . . . lower costs.

No other line of bimetal thermostats has as many different styles in production. So if you want close control, compactness, light weight — you'll find them all in Stemco thermostats. Combined with Stevens application engineering service, you profit from important savings of being able to use a production line Stemco thermostat for your special needs.

Let's match our experience and enthusiasm against an hour of your time. A card or call will bring our representative on the double.

STEMCO thermostats

sensitive • close control
quick acting • positive acting
snap acting • shock resistant
light • compact • adjustable
non-adjustable
open type
hermetically sealed

manufacturing company, inc.
Mansfield, Ohio

Protective Coating for Sheet Metal

In a new method of laminating vinyl plastic and sheet metal or aluminum, to make these metals colorful and permanently rust and corrosion proof, the resulting laminate is said to have a higher abrasion resistance than varnish, paint and baked enamel finishes. In addition, 180 deg bends and deep draws can be made without separating the vinyl from the metal.

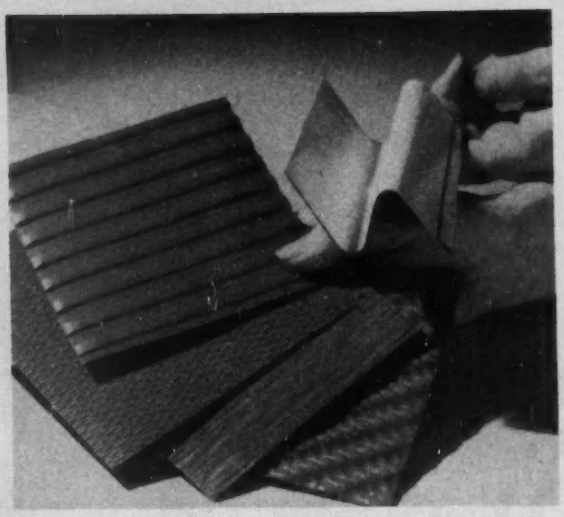
The cost of the laminate is said to be higher than galvanized iron, but only about one-third the cost of comparable gage stainless steel.

The laminate is made by rolling rigid or semi-rigid vinyl sheet onto heated adhesive-coated metal sheets or strips. The rolling pressure is not high. After rolling, adhesion is effected in seconds under heat lamps or another suitable heat source.

To date, cold-rolled steel, hot-rolled pickled steel and aluminum, from 18 to 34 gage, have been used to make the laminate. The vinyl films used have ranged from 0.002 to 0.02 in. thick.

Tests on the finished laminate indicate an adhesion in excess of 40 lb per sq in. of width. This high adhesion permits the laminate to be fabricated with all types of regular metal-forming equipment without damage to the coating.

The laminate can be sheared, drilled or punched without chipping. Crimp rolls, 90 deg crimp bends, 180 deg bends and deep draws can all be made without damaging the coating. No special techniques are required, and the only limitation in fabrication is that soldering, welding or brazing cannot be used without removing the coating for a short distance on either side of the seam. However, joints and exposed metal at cut edges can be protected.



In the illustration, the vinyl coating was applied to the metal before the design was imprinted, and was undamaged after the design was applied.

United States Rubber Co., Rockefeller Center, New York 20, N. Y.

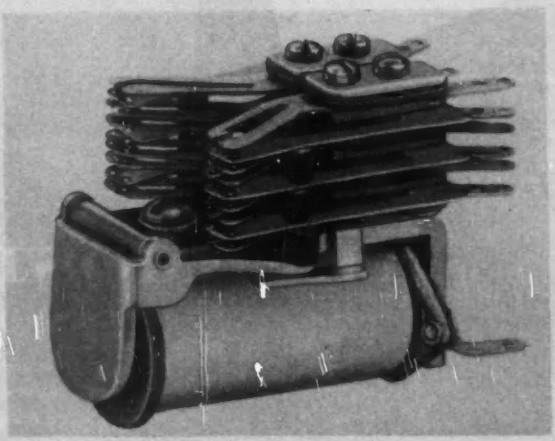
New Line of Relays Offers Wide Application

A newly developed line of relays, among which are the series 100 d-c computer relay; the series 300 d-c miniature relay; the series 400 a-c or d-c coaxial relay; and the series 500 d-c communication relay, has special features for each class. For example, the bearings of the series 100 d-c computer relays have essentially zero friction and the relay has a life span of ten million cycles. In addition, the magnetic efficiency of the extra heavy frame produces unusual speed and sensitivity. Such features make it applicable for digital computers, airborne marine and mobile instrumentation, and industrial communications.

The series 300 d-c miniature relays weigh under 2 oz and incorporate a special anti-vibration feature which makes them particularly resistant to vibration and shock. This is done by the extra magnetic force developed by the more permeable iron-to-iron hinge arrangement which operates an anti-vibration spring. Another feature is the elimination of hinge pins or hinge springs.

The series 400 d-c or a-c coaxial relays withstand 10 G vibration at 10-55 cycles per sec. under operation tests. They are designed for use up to 400 Mc at moderate power. They are supplied for up to 220 v a-c or d-c.

Since the series 500 d-c communication relays can perform mechanical work in additon to operating contacts, they are ideal for those applications where automatic punching is required for control system applications. They are also ideal for slow release and operate relays without resorting to large frame telephone relays.



Joseph Pollak Corp., 81 Freeport St., Boston 22, Mass.

CONTINUED ON PAGE 222

Introducing . . .

HOLTITE NYLOK SCREWS

Reg.

ONE-PIECE SELF LOCKING SCREWS AND BOLTS

. . . SAVES YOU TIME AND MONEY!

Eliminates safety wire, lock washers, jam nuts, and all other locking devices.

The new Holtite-Nylok screws and bolts employ a nylon insert in the threaded section that provides a smooth, positive locking action. Seated or unseated, they lock where stopped.

. . . PLUS THESE EXTRA ADVANTAGES

- Positive Locking
- One piece; eliminates separate auxiliary parts
- Readily replaced
- Interchangeable
- Re-useable
- Locks seated or unseated
- Defies vibration
- No harm to mating thread of parts
- Acts as a seal for gases and liquids under high pressures

HERE'S WHY HOLTITE-NYLOK LOCKS SECURELY

HOW NYLOK LOCKS
(Patented)

Resilient Nylon plug (A) sets up lateral thrust, smoothly wedging mating threads together (B). All of locking action is on the threads; head is not stressed. Locking is positive seated or unseated.

YOU CAN ALWAYS COUNT ON CONTINENTAL'S ENGINEERING SERVICE

As Holtite-NYLOK fasteners are presently intended for specific applications, our engineers welcome the opportunity to study your individual requirements and make recommendations for the most efficient and economical applications.

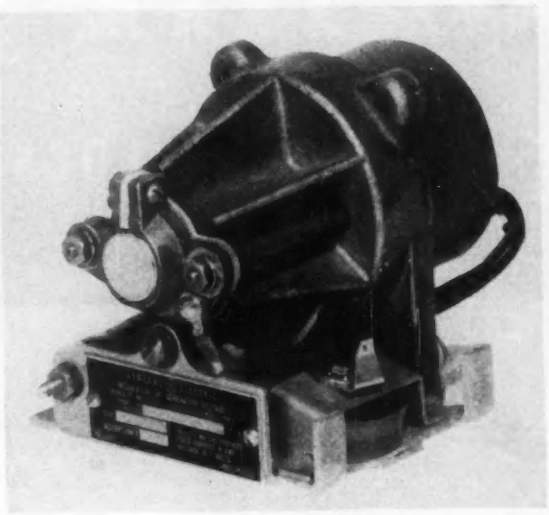
Why not check your own assemblies today. There's a good chance Holtite-NYLOK can boost your output, and save you money.

Light Weight Carbon Pile Regulator

An improved 28 v d-c carbon-pile regulator of the plug-in type and a companion vibration-isolation mount has been designed for use in aircraft electrical systems and has been reduced to 2.95 lb while maintaining a high heat dissipating quality of 90 watts. The recovery time of the regulator is fast, regaining rated voltage and stabilizing within 10 percent in one-tenth of a second going from no load to full load or vice versa. Applicable to many of the 30 v d-c generators now in use, the usable resistance range of the variable resistor is 1.25 to 34 ohms. The regulator can maintain constant output voltage within plus or minus 2½ percent over wide variations in speed, load, and temperature.

The new center-of-gravity vibration mount for use with the regulator includes a ribbed terminal board to protect against short circuits due to loose hardware. The vibration mount permits the regulator to be mounted in any plane, transmitting less than 1G vibration to its protected device when subjected to a 10G displacement equivalent at frequencies from 60 to 200 cycles.

General Electric Co., Schenectady 5, N. Y.



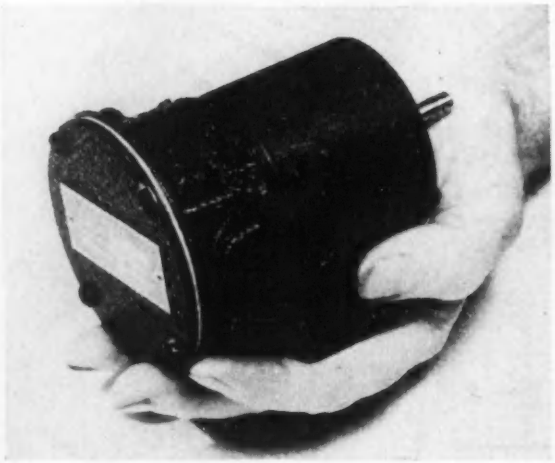
Slow Speed Control with Zero Speed Switches

Control at slow speeds is possible with a new series of Dazic zero speed switches having shaft driven contractors equipped with single pole double throw snap-action contacts rated at 10 amp, at 110 v, a-c. Of all metal construction, the units are self-lubricating, having hydraulically driven mechanism and magnetically coupled electrical contacts.

They can be wired to open or close signal circuits on shaft rotation of 15 rpm on acceleration, and 8 rpm on decreasing shaft speed. The new model Dazic will indicate direction of rotation and will indicate idling when shaft is stationary. They can be driven at speeds ranging thru 5,000 rpm, at temperatures from —20 to +250 F. The required driving torque is 3 in.-oz, and the unit can be mounted in any position.

Applications include: use as conveyor controls and interlocks; operation of braking equipment; and adaptation as plugging switches. It is also used in wire mills to detect broken wire in bunch stranding operation.

Winterburn Mfg. Co., Putnam, Conn.

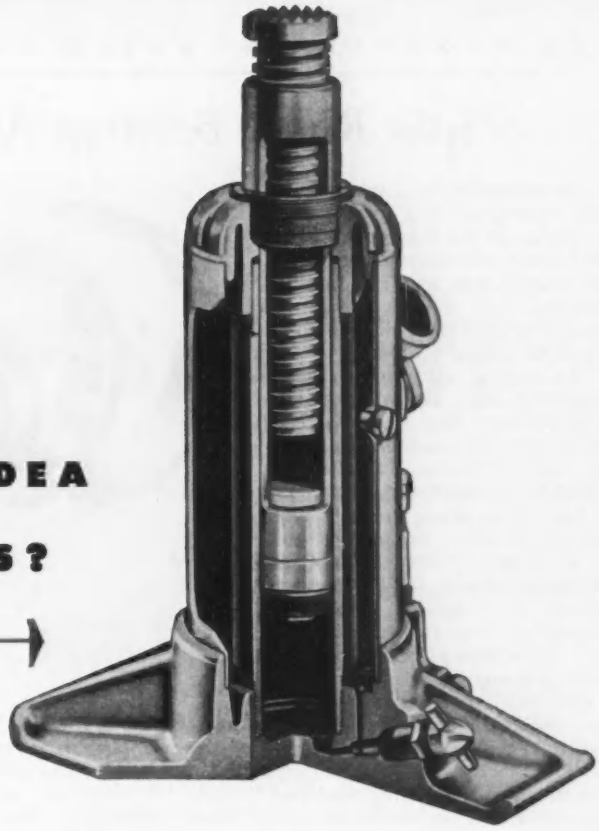


INSTALLING AND LEVELING HEAVY MACHINERY without bolting or shims is now possible wth the new series LM3 and LM5 self-leveling mounts. These new vibration isolators are said to give plants increased mobility of machine tools, while eliminating bolting of machines to the floor. Also isolates horizontal, vertical and rotational vibration, and prevents "floor walking" of heavy machines. The mounts permit height adjustments up to ½ in. and carry loads up to 4,200 lb per mount. Barry Corp., 1000 Pleasant St., Watertown, Mass.

ONE-PIECE SELF-LOCKING SCREWS AND BOLTS now have a nylon insert which conforms to the curvature of the screw threads, and gives a positive locking action when stopped. The nylon plug sets up a lateral thrust, with all of locking action being on the threads. The depth of the hole for the nylon plug is not weakened. Features: locks seated or unseated; seal for gases or liquids; reusable; used at temperatures from —50 to 250 F. The Continental Screw Co., 110 Mt. Pleasant Ave., New Bedford, Mass.

CONTINUED ON PAGE 224

CAN YOU LIFT AN IDEA FROM THIS?



● Inside that jack, the lifting cylinder must withstand concentrated pressures. Outside, the housing gets rough service.

What material would you use to do the job?

Manufacturers of hydraulic jacks use Republic ELECTRUNITE Welded Steel Tubing . . . whether they make jacks that raise cars . . . or houses. They find ELECTRUNITE has the high strength that stands up under this kind of pressure. Takes rough service in stride.

Republic ELECTRUNITE is often cheaper. It's uniformly concentric, and that eliminates costly machining for close-tolerance parts. Makes a strong jack handle, too.

There may be a place for Republic ELECTRUNITE Welded Steel Tubing in something you plan to produce. Or in your present products. We'll be glad to help put ELECTRUNITE Tubing to work for you . . . in the right places. Just write:

STEEL AND TUBES DIVISION
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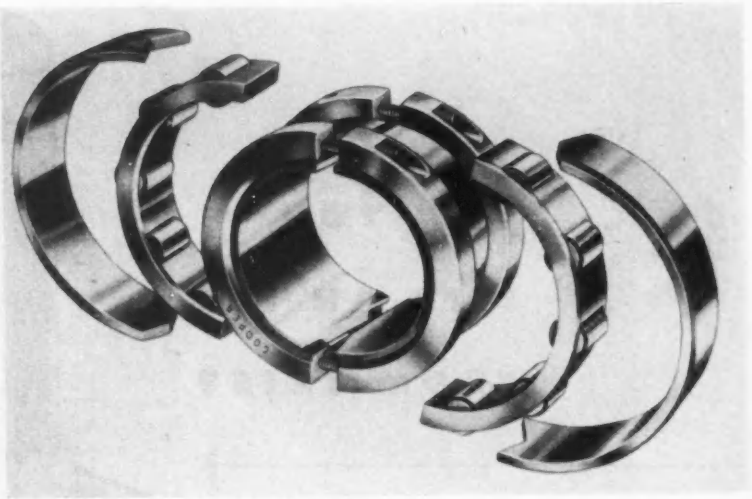
Republic
ELECTRUNITE TUBING

MADE BY THE PRODUCERS OF ELECTRUNITE...THE ORIGINAL ELECTRIC WELDED BOILER TUBE

Split Roller Bearings Aid Assembly

The components of a new split type roller bearing are split right down to the shaft, and the bearing can be applied where it is impossible to mount conventional type solid ball or roller bearings. This split design permits an anti-friction roller bearing to be assembled around the shaft.

The bearings are made in halves throughout. Races and rollers are high carbon-chrome alloy steel, hardened for strength and maximum load carrying capacity. Races and rollers are accurately ground with a high finish to fine limits. Races are split on a diagonal to insure continuity of contact area between roller and race. Cages are aluminum alloy for lightness and strength. Cartridge and pillow block housings are stress-free grey iron castings, with machined elements held to close tolerances.



The models available are: the fixed type (sometimes called grooved-race bearings) used as shaft locating and radial-thrust bearings; expansion type (sometimes called floating type bearings) used to accommodate end play and shaft expansion. The bearings are housed in split cartridges with self-aligning, spherically ground OD, which are mounted in machined split pillow blocks. Three series of standard bearings are offered: the medium series with bore sizes from $1\frac{3}{16}$ to 12 in., the heavy series with bore sizes from $1\frac{1}{8}$ to 12 in., and the extra heavy series with bore sizes from 3 3/15 to 12 inches.

The halves of the inner race are clamped onto the shaft with locking collars. Bearing assembly is completed by placing the halves of the outer race in position. Split cartridge or other split housing is fixed around bearing, which is then ready for use. The split feature does not in any way limit the application of the bearings, and increases both the maintenance and machine economy.

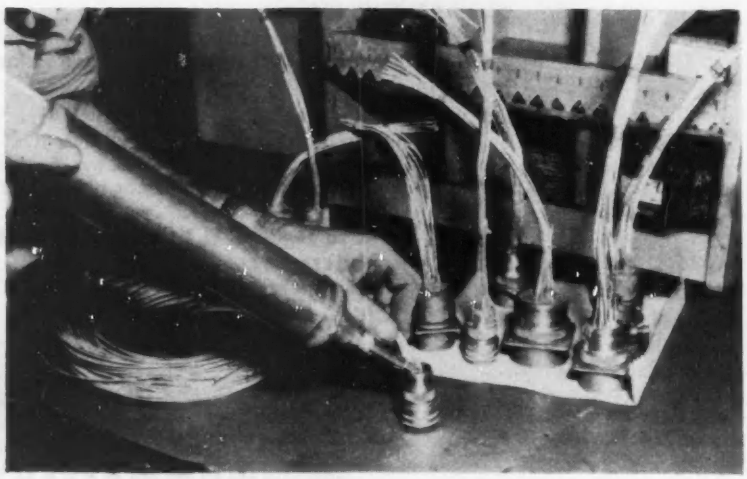
Cooper Split Roller Bearing Corp., 700 Cedar Blvd., Pittsburgh 28, Pa.

Dielectric Sealer for Wiring Connections

Developed initially for the aircraft industry but also found useful by electrical equipment manufacturers, a new dielectric sealer has been designed for use as a flexible potting compound on electrical wiring connections. It retains physical properties throughout a temperature range of —65 to 200 F, and has good dielectric properties, moisture and water resistance.

Called the EC-1120 dielectric sealer, it is a synthetic rubber material that is applied in liquid form. It cures by chemical reaction to a tough, rubber consistency that gives protection against corrosion, vibration, fuels and oils, and salt air.

Two advantages claimed are: (1) The sealer is flexible, eliminating the danger of wire breakage due to bending or vibration; and (2) permits simplified design of connector plugs and eliminates excess weight.



Minnesota Mining & Mfg. Co., 423 Piquette Ave., Detroit 3, Mich.

CONTINUED ON PAGE 226

The second of two articles on profits

What Are PROFITS Used For?

This is the second article on the role of profits in our economy. The first was addressed to the question: "How High are Profits?" The answer was found to be: not high when compared with previous years and the present investment in corporate facilities. This second article is addressed to the equally important question: "What do corporations do with their profits?"

In 1953 corporations will earn about $20 billion *after taxes*, if the recent rate of earnings is maintained throughout the year. These profits will be used (1) to expand and improve productive capacity through purchases of new plant and equipment, (2) to finance the operations involved in a growing volume of business and (3) to reward the people who have invested their money in American industry. Of the $20 billion, the corporations will pay about $9 billion to their stockholders as dividends. They will use the $11 billion that remains to purchase new plant and equipment and to increase their working capital.

This year corporations are increasing their plant, equipment and working capital by a total of approximately $32 billion. Of this amount, about $26 billion is for new plant and equipment. The remainder is for working capital. As this article will show in greater detail, about $21 billion of this will come from depreciation allowances and sales of new securities. The other $11 billion will come from retained profits.

It is impossible to trace exactly how each dollar of retained profits is spent. This money is mixed with other money that goes into the company treasury in the form of proceeds from loans, sale of securities and depreciation allowances. *However, it is a fact that by retaining $11 billion of their profits this year, corporations have provided $11 billion toward their total capital requirements, including the money needed for expanded and improved capital equipment.*

Profits Mean New Plants

This year American industry is engaged in a very large expansion of plant facilities. This will increase the industrial capacity of the nation by about 7 per cent. Since 1950, our capacity has been increased by about 12.5 per cent. And all of this expansion has been privately financed, even though about one-third of it was certified as necessary for national defense.

The expenditure during 1953 of $26

billion for new plant and equipment—an alltime record—imposes terrific financial responsibilities on our corporations. About one-half of the amount required will come from depreciation allowances. In general, these allowances are supposed to pay for the replacement of worn-out or obsolete equipment. Another $8 billion will be raised by corporations through new security issues and long-term mortgage loans. All together, depreciation allowances, security issues and long-term loans will provide about $21 billion. But this is still $5 billion short of the $26 billion needed for new plant and equipment this year. Thus, it is retained profits that spell the difference between expansion and standing still, between growth in the productive capacity of the economy and running downhill.

As plant facilities are expanded, corporations also need more working capital. A larger volume of business requires larger inventories, larger accounts receivable and larger amounts of ready cash to meet payrolls and bills for materials. The increase in these items during 1953 is estimated at $8.5 billion, of which about $2.5 billion will be supplied by short-term bank loans. The other $6 billion will come from retained profits. Thus, retained profits provide an essential $11 billion—$6 billion for working capital, $5 billion for new plant and equipment—to meet corporate financial requirements.

Incentive for Investment

The role of the profits that are paid to stockholders as dividends or to employees under profit-sharing plans is even more important than the role played by retained profits in providing plant, equipment and working capital. Dividend payments provide the main incentive for investment in the stocks of corporations. They are the reward for risks taken by investors. Dividends paid by corporations whose common stocks are listed on the New York Stock Exchange provide an average return of about 6.5% at present prices, and dividends on preferred stocks average about 4.5% return. Dividends are distributed among 6.5 million stockholders. Also, it is estimated that 3 million employees now are covered by profit-sharing plans. These plans increase the incentives of both production workers and managers to work harder and more efficiently.

Thus, more than 9 million Americans have a *direct* financial stake in corporate profits through ownership of stock or participation in profit-sharing plans. But *all* Americans share indirectly in the rewards of a successful business year. Investment of a major part of 1953 profits in new plants and equipment means more employment opportunities and better working conditions for labor. For the nation, it means new industrial capacity that is essential both for national defense and to produce more and better goods for a rising standard of living.

Corporate profits after taxes represent about 6% of the nation's total income. But the job they do to stimulate investment and to finance industrial expansion and improvement is more far-reaching and more essential to the prosperity and well-being of the American people than would be suggested by that small figure.

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Contact KAYDON of Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER

Special KAYDON two-row Angular Contact Ball Bearings, 12.000" x 13.440" x 1.375" (THIN SECTION)

These KAYDON-bearinged BELL Anti-Submarine Helicopters won't be outsmarted!

NAVY'S latest "bad news" for unwelcome submarines are the HSL-1 Bell Helicopters . . . most powerful tandem-rotor 'copters known . . . big but compact, with high speed, long range and all-around performance "beyond expectations".

Special thin-section KAYDON two-row angular contact ball bearings, used on the swash plates, contribute much to the compactness, speed, controlability and stability of these modern defenders of America. • KAYDON cooperates with many designers and technicians in terms of precision bearings that improve aircraft, automotive, military and industrial equipment . . . to help make many products better, faster, more profitably.

On units you *make* to *sell*, or *buy* to *use*, specify KAYDON bearings. Contact KAYDON of Muskegon.

THE KAYDON ENGINEERING CORP.

KAYDON Types of Standard and Special Bearings:
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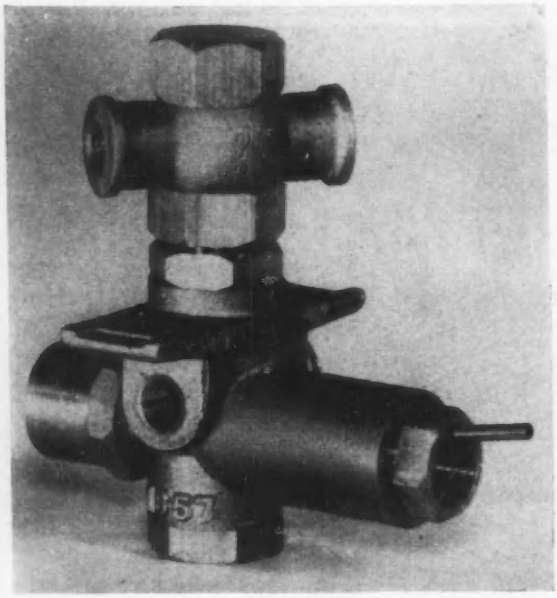
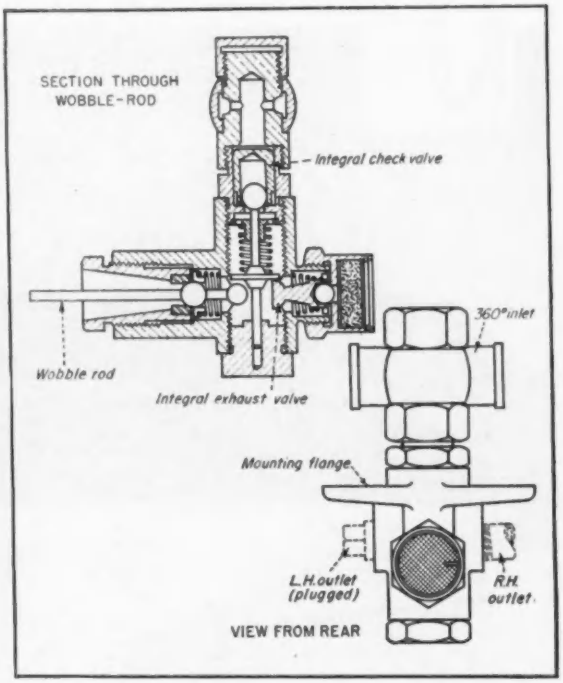
MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS



THE WOBBLE ROD at the lower right will swivel to any point in its circular opening. The inlet at top is adjustable 360 degrees around the valve body, and is secured by a hex cap.



Air Operating Valve Actuated In Any Direction

Because of its unique operating principle, and flexibility of both mounting and application, a new wobble-rod-valve (with integral exhaust) offers new possibilities in the design of pneumatically-operated equipment.

The lever which opens and closes the valve is a rod so swivelled that the free end can move vertically, laterally, diagonally, or in arcs and circles. Therefore, the valve can be actuated (manually, mechanically, or electrically) by all manner of motions. It allows lateral play during a vertical throw; permits direct linkage to rotating, oscillating, toggle, lever, slot, or straight thrust mechanisms; it can be adapted to cyclic operation by passing the lever-rod through an eccentric hole in a rotating disk or gear; and it is easily spring loaded to remain normally open rather than normally closed.

Its internal exhaust valve will automatically discharge an air cylinder, line or receiver when the valve closes, but can be eliminated where it is desirable to hold air line pressures after the valve has operated. Another integral feature is a check valve to prevent backsurge.

The body casting is designed to permit two valves to be assembled into one unit. Such an arrangement can provide a common inlet and outlet, simple series connection, or total independence of the two valves. Therefore, three-way, four-way, tandem, or synchronized operations can be used through lever-rod linkage.

Bronze, brass and stainless steel are used throughout. There are no rubber or fiber seats or diaphragms. Mating parts are designed to seal without gaskets or packing, and are threaded together without bolts or flanges.

Referring to the diagram, when the wobble rod is depressed, a ball on its inner end raises a valve stem which lifts the ball from its seat. The air can then pass through the valve. When the rod is released, the valve reseats. At the same time, the stem depresses and opens the integral exhaust valve. Backsurge from the attached equipment raises the integral check valve which closes the inlet port.

Its range of usefulness is up to 125 psi. Open valve diameter is $\frac{1}{4}$ inch. Overall dimensions are $3\frac{1}{8}$ in. by 5 in. by $4\frac{5}{8}$ in. high. Weight is $2\frac{1}{4}$ pounds.

Pantex Mfg. Co., 521 Roosevelt Ave., Pawtucket, R. I.

USING A STEEL BAND TRANSMISSION instead of the conventional rack and pinion method, a new precision dial indicator is accurate over its entire range. The band also functions as a safety device absorbing shocks. Another feature is the measuring pressure compensator, which gives a constant measuring pressure on the anvil over its entire range. Indicators are graduated in 0.0005 in., and with a range of 0.400 inch. A knob permits zero setting at the 12 o'clock position. Homestrand, Inc., Larchmont, N. Y.

A NEW PLASTIC TEMPLATE for drawing screw threads covers the range from 20 to 4 tpi of the most commonly used American standard threads. This includes all screws diameters from $\frac{1}{4}$ to 4 inches. Rapidesign, Inc., P. O. Box 592, Glendale, Calif.

CONTINUED ON PAGE 228

EEMCO

technical bulletin

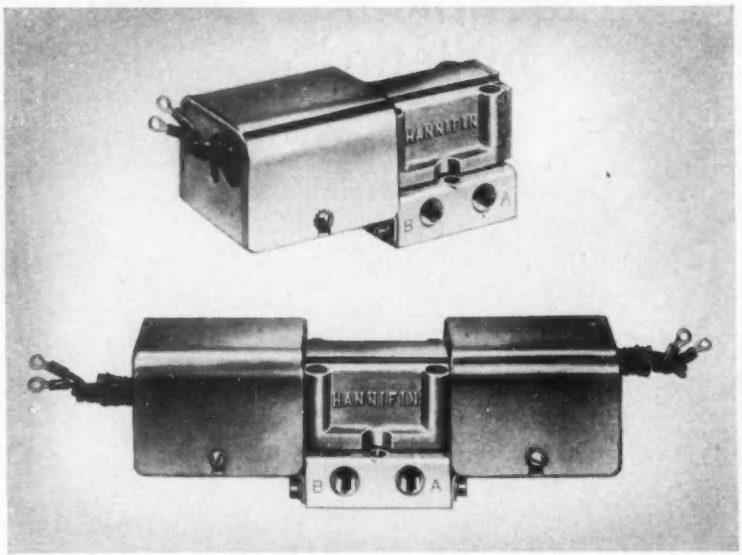
SPECIAL MOTOR FOR *shock* LOADS

This specialized EEMCO motor design employs an in line double spur gear reduction for heavier operating loads or applications where shock loads are experienced, such as air compressors. It is rated at 2½ h.p. for continuous duty, 27 volts D.C. Output speed is 3650 RPM. Unit includes radio noise filter and standard AND 20001 mounting pad and drive.

ELECTRICAL ENGINEERING & MFG. CORP.
4612 West Jefferson Blvd.
Los Angeles 16, California

3-519

Direct Solenoid Operated 4-Way Valves



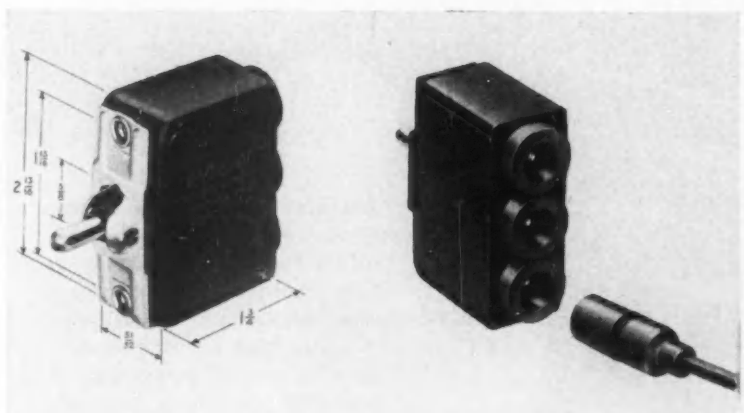
Designed as companion valves to the larger, pressure-operated, solenoid-controlled, 4-way pilot-master valves, two new ¼ in. 4-way poppet-type valves in the P-M line are direct solenoid operated, compact and simple, and fast operating. They are recommended for speeds as high as 600 cycles per minute. Their principal use is expected to be for the electric control of small, double-acting air cylinders on short stroke, high speed applications. Examples are switching mechanisms for conveyors, welder cylinders, and clamping and work-positioning cylinders on various automatic and semi-automatic machines.

The CC1-25 is a single-solenoid model, and the single valve stem, which is the only moving part, is spring returned. Model CC11-25 has two solenoids, and its single valve stem remains at either end of its stroke until the other solenoid is momentarily energized to return it. This makes momentary contact operation possible, eliminating the necessity, with a single-solenoid valve, of keeping the solenoid energized as long as it may be desired to hold the valve in its shifted position. The need for a holding relay is eliminated with this valve. It also eliminates the danger that a cylinder might accidentally reverse and damage the work or injure the operator in the event of an electrical power failure.

Another feature of these valves is that pipe or tubing connections are to a separate manifold, to which the valve mounts.

Hannifin Corp., 1122 S. Kilbourn Ave., Chicago 24, Ill.

Waterproof Toggle Switches



Two new series of waterproof toggle switches, designated type ACM, feature a molded in female waterproof connector receptable, designed for assembly with male waterproof plugs. This eliminates the need for vulcanizing leads to the switch and also allows standard model switches to be used with any length leads. Both types of switch are compact, and are entirely encased in a specially developed molded rubber compound. All metal parts are plated for corrosion resistance. The switches are 100 percent waterproof, meet government specifications for waterproof toggle swtiches, operate satisfactorily from —65 to 160F, and withstand shock and vibration.

Series 29-ACM, shown in the illustration, is a flush mounting switch, with capacities on resistance type load of 25 amp at 24 v d-c, and 15 amp at 125 v a-c. Series 19-ACM is one-hole mounted, with a specially designed waterproof barrel that eliminates need for a seal nut or outside panel seal. Capacity on resistance type load is 25 amp at 24 v d-c, and 11 amp at 125 v a-c. Each switch is available either SPST or SPDT, in eight different toggle arrangements.

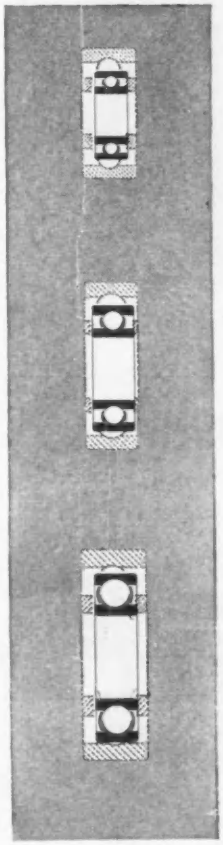
Riverside Mfg. & Electrical Supply Co., 10228 Michigan Ave., Dearborn, Mich.

CONTINUED ON PAGE 230

for THRIFTY SAVING in power, weight and space

SPECIFY Micro BEARINGS

DESIGN YOUR PRODUCT WITH THE THRIFTY-SAVING RETAINER EXTRA-LIGHT



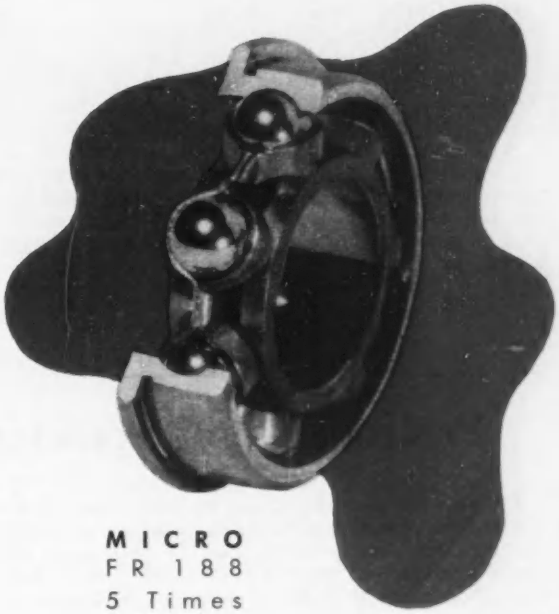
White Area Indicates Loss when specifying common sizes

bore 1/8" **MICRO** R144
Saving 80% in space and weight over common R2 bearing shown in white

3/16" **MICRO** R166
Saving 69% in space and weight over common R3 bearing shown in white

1/4" **MICRO** R188
Saving 69% in space and weight over common R4 bearing shown in white

Illustration Two Times Actual Size



MICRO FR 188 5 Times Actual Size . . .

Peeling off all excess metal we are now able to furnish a smaller bearing in the various shaft sizes. Thus we have produced a load-carrying package of minimum weight and size.

Arthur K. Daniels

Frequent losses occur in designs calling for bearings with capacity far beyond requirements

DESIGN LOADS FOR 1 MILLION REVOLUTIONS

MICRO R144 — 52	Common R2 — 108
MICRO R166 — 120	Common R3 — 194
MICRO R188 — 224	Common R4 — 260

NEW HAMPSHIRE SPECIFY Micro BEARINGS **BALL BEARINGS, INC.**
53 MICRO CIRCLE PETERBOROUGH, N. H. TELEPHONE 424

Write for Catalog 53 for complete data on the more than 130 available **MICRO** Bearings, or consult our Design Engineering Department

Heavy Duty Mercury Contactor

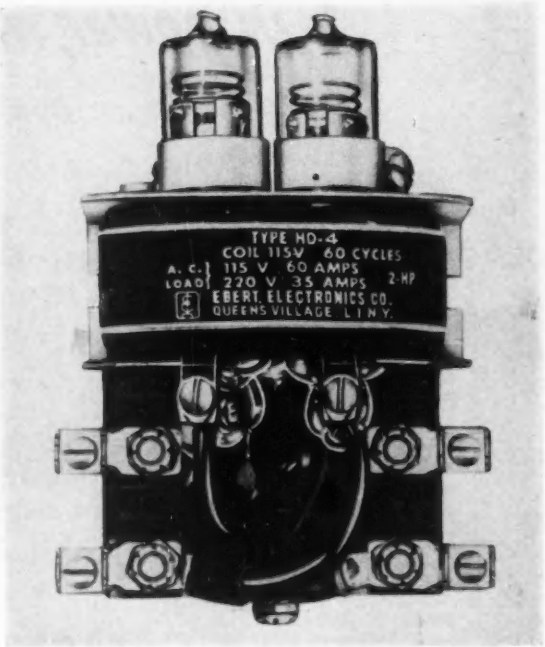
For positive, safe motor control functions, and for all heavy duty control applications, this new mercury contactor, HD-4 features mercury-to-mercury contacts, is silent, chatter-free, hermetically-sealed, explosion-proof, and requires no maintenance. The small overall dimensions are 5 x $3\frac{3}{8}$ x $2\frac{1}{4}$ in., and the high current-handling capacity permits savings in space.

The HD-4 is a two-tube contactor. Each tube will control 60 amps at 115 v a-c, and 35 amps at 230 volts, a-c. For d-c, control capability per tube is 12 amps at 115 volts. For motor control, the HD-4 is rated at 2 hp at 115 v, a-c (single phase), 3 hp at 230/440 v, a-c (single phase), and $\frac{1}{2}$ hp at 120/220 v, d-c. Coils are available for a variety of control voltages.

The HD-4 can be obtained with both tubes normally open or both tubes normally closed. For special applications, such as in standby power or switching, it is available with one of the tube contactors normally open and one tube normally closed.

Among some of the products where mercury relays are successfully used are: call systems; furnace and oven controls; motor controls; standby power controls; neon sign controls; temperature controls; and traffic light controls. A few other applications are: street lighting; burglar alarms; and incubators and brooders.

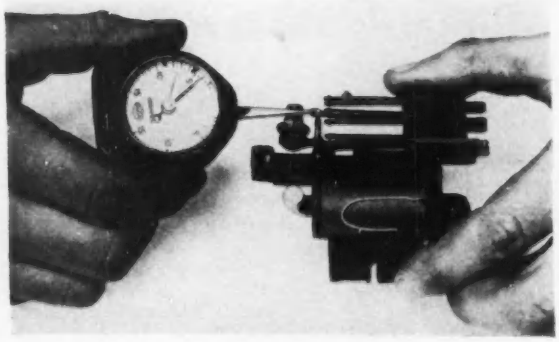
Ebert Electronics Co., 212-216 Jamaica Ave., Queens Village 28, L. I., N. Y.



Precision Dynamometer Checks Small Machines

Designed for measuring spring tension, starting torque and the force required to actuate delicate mechanisms, a new precision dynamometer can be used in determining and checking the pressure required to overcome spring tension and other kinds of resistance in such components as: precision mechanisms such as electric contacts, relays, telephones, clocks, business machines, micro-motors for electric razors, windshield wipers, time switches and others.

The instrument is available in two models, small and large, each in several ranges in grams of pressure, acting in both directions. The small model is available in ranges: 5-15, 5-30, 10-50, 20-100 and 25-150 grams. The large model comes in ranges from: 25-250, 50-100 and 100-1000 grams. To eliminate the necessity of observing and watching the graduation, a special friction leader hand, moved by the indicator hand, will stop and remain set at the highest point of pressure. The hand is set back by the knurled knob.



George Scherr, Inc., 200 Lafayette St., New York 12, N. Y.

A 5 OZ SOLENOID VALVE with the efficiency of a larger valve operates up to 1,000 cycles per min, has a pressure up to 200 psi, a straight through flow and a power consumption of from one to three watts. It is available in 6, 12, 24 v d-c, and 100 v a-c, with special voltages possible. Major parts are stainless steel, silver brazed for rigidity, with no gaskets used. Standard models have $\frac{1}{16}$ in orifice. No mounting brackets are necessary. Specialty Products Co., Inc., 3725 Monitor Ave., Minneapolis 16, Minn.

FEATURES of the new 1200 series continuous duty reversible d-c motor include ambient temperature of from —55 C to +105 C, 18 to 30 v with or without brake. Size is 1.25 in. dia by 2.18 in. long. Motordyne, Inc., 2661 S. Mrytle Ave., Monrovia, Calif.

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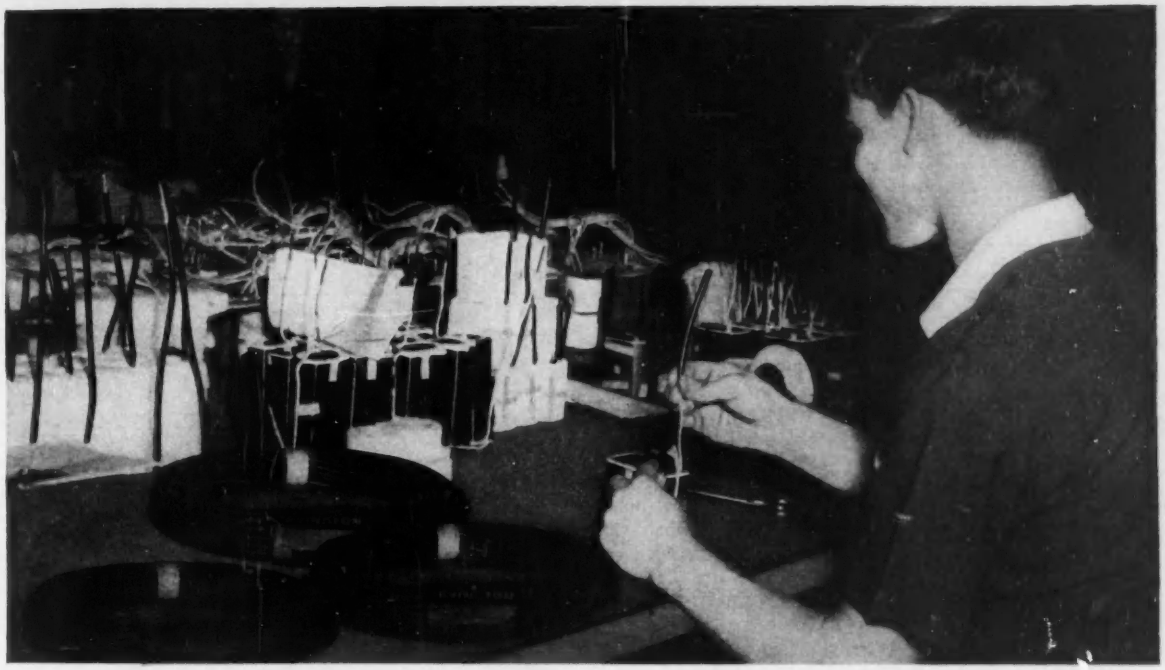


"Protection up to 17,000 volts maintained by TEMFLEX® 105 TUBING," reports I-T-E

Irvington's Temflex 105 Plastic Tubing is the choice of I-T-E Circuit Breaker Company for protecting the leads of small transformers which are varnished and baked with the lead wires exposed. If the varnish insulation should crack after repeated bending, the Temflex 105 Tubing maintains protection up to 17,000 volts.

Specifically formulated for high-temperature service, this product of Irvington's Fibron division has Underwriters' Laboratories approval for *continuous* operation at 105° C. in air — *and at 90° C. in oil.*

Other advantages of Temflex 105 Tubing are its high dielectric strength, smooth interior surface which contributes to ease of assembly, attractive appearance, retention of flexibility under severe service conditions.

Temflex 105 Tubing is produced in all standard colors — and is identified by the continuously printed name on the smooth surface. Specify it by name when you buy.

Look to
for Insulation Leadership
IRVINGTON
INSULATING VARNISHES
VARNISHED CAMBRIC
VARNISHED PAPER
VARNISHED FIBERGLAS
INSULATING TUBING
CLASS "H" INSULATION

*T.M. Reg. U.S. Pat. Off.

A Technical Data Sheet gives complete information — mail the coupon for your copy

Send this convenient coupon now

Irvington

VARNISH & INSULATOR

DIV. OF MINNESOTA MINING & MANUFACTURING CO.

10 ARGYLE TERRACE, IRVINGTON 11, N. J.

Plants: Irvington, N. J.; Monrovia, Calif.; Hamilton, Ontario, Canada

Irvington Varnish & Insulator PE12/53
Div. of Minnesota Mining & Mfg. Co.
10 Argyle Terrace, Irvington 11, N. J.

Gentlemen:

Please send me Technical Data Sheet on Temflex 105 Tubing.

Name..... Title.....

Company.....

Street.....

City..... Zone..... State.....

Glass, Heat Operated Pump Has Many Uses

Unlike mechanical pumps, a new type heat operated pump offering special advantages, can be made entirely of glass and hermetically sealed, permitting safe pumping of dangerous or corrosive liquids or chemicals. It has no moving parts except check valves, operates indefinitely and silently.

Other applications include pumping fuel oil for such devices as small stoves, furnaces and blow-torches, powering automotive accessories, toys and animated displays, and pumping refrigerants, as in absorption refrigerators, where waste heat can be utilized and fed back to power the pumping unit.

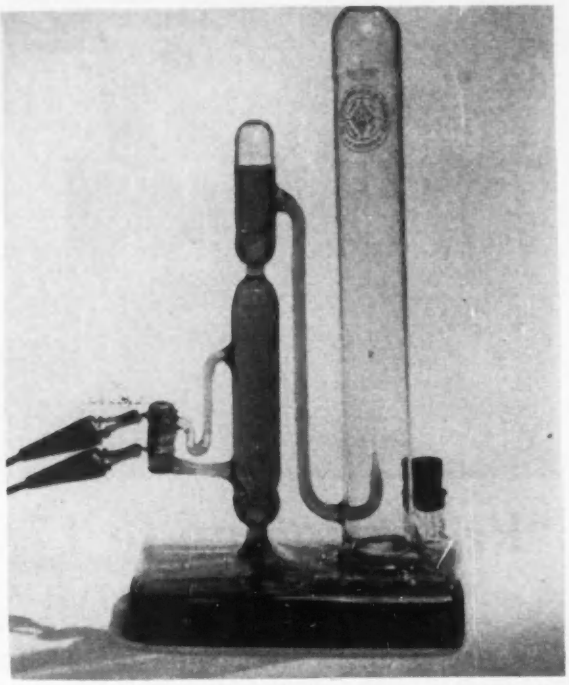
Called the Thermo-Pump, it operates by vaporizing fluid in the generator column (left), forcing vapor bubbles through tube into condenser (center column), where vapor collects until pressure forces it through upper check valve (pinched section in condenser). When the vapor rises through the valve, it condenses and is forced through an outlet jet in the right hand glass column.

As the vapor leaves the lower section of the condenser, a hydrostatic unbalance results, forcing cool fluid into the generator to be vaporized. At the same time, a partial vacuum occurs, opening a lower check valve and pulling in new fluid from tank.

Lower in efficiency compared to mechanical pumps, it can also operate where electric or mechanical power is unavailable or inconvenient, as in certain laboratory situations or inaccessible regions.

Based on a simple principle of vaporizing and condensing liquids, the new, compact pump operates on very small amounts of either electric or flame heat, comparable to the coffee percolator.

Basic pressures and flow rates have been increased until small models can develop pressures of 25 lb to the square inch, and, moreover, through these increases in pressures and flow rates, even very small models can pump up to 8 gal of fuel oil per hour.



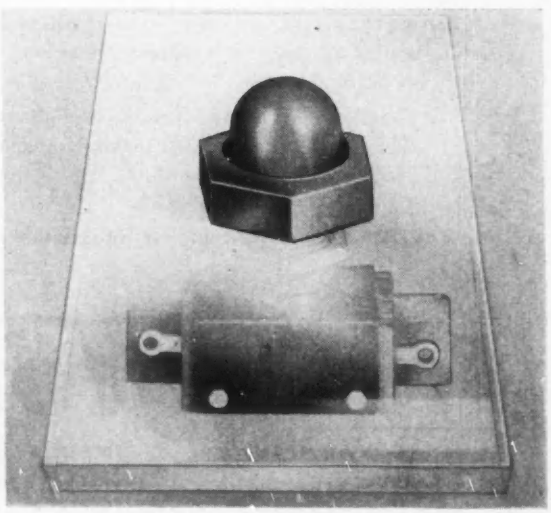
Jet-Heet, Inc., 152 S. Van Brunt St., Englewood, N. J.

Hermetic Seal for Standard Push-Button Switches

The latest additon to a line of switch boots is the Hexseal series 3030. The new units are high-pressure hermetic seals for all standard push-button switches. When installed, the boots replace the switch lock-nuts on the exterior of the panel, and serve as both seal and lock-nut. Hermetic sealing is maintained by a gasket rib, an integral part of the boot, which seats against the panel to keep out moisture, dust, or combustible vapors.

Made of silicone rubber, which is chemically bonded to the nut, the covers are flexible from —80 to 500 F, and are unaffected by exposure to sun and weather. The material used is said to surpass the requirements of MIL specification B-5423.

Being of single unit construction, the new seals require no assembly. Because they can be hand-tightened, special hardware or wrenches are not needed, and spare parts inventory is kept at a minimum. The model illustrated is grey and has $\frac{15}{32}$-32 TPI; other thread sizes and colors are available on special order.



Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers 5, N. Y.

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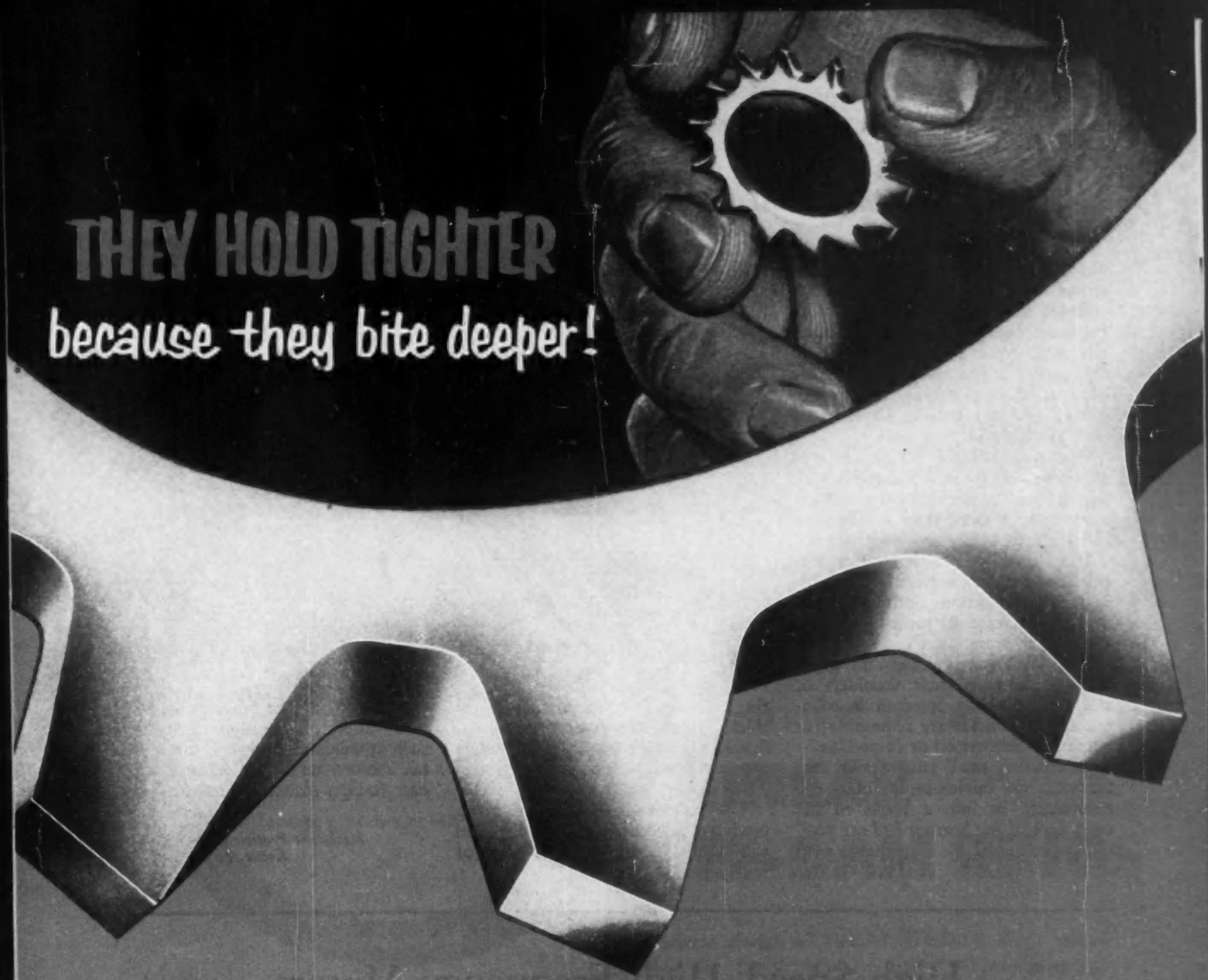


SHAKEPROOF® LOCK WASHERS

Vibration? Use SHAKEPROOF Lock Washers. Exclusive tapered-twisted locking teeth bite deep . . . and actually lock even tighter as vibration increases. They resist any backward rotation of screws or nuts . . . assure positive protection against loosening due to vibration.

FREE...

TESTING SAMPLE KIT

. . . contains a wide variety of SHAKEPROOF Lock Washer types and sizes for actual testing on your own product. End vibration loosening problems now . . . Send for your kit today!

SHAKEPROOF®

"Fastening Headquarters"

DIVISION OF ILLINOIS TOOL WORKS

St. Charles Road, Elgin, Illinois • Offices in principal cities

In Canada: Canada Illinois Tools Limited, Toronto, Ontario

America's Great Resources Plus A Free Economy Made This Business Possible!

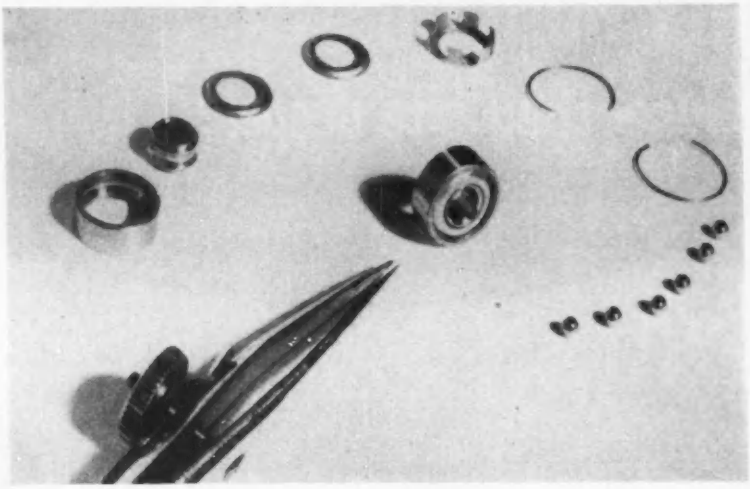
Miniature Bearings Have Dirt Protection Shield

Dirt, lint and contaminated atmosphere have been protected against in a new series of single and double-shielded miniature fractional inch size precision ball bearings of both full race and retainer type construction. Previously unavailable in miniature bearings, these new bearings, down to 0.1562 (5/32 in.) outside diameter are now available in nine sizes.

The single shield design bearings are dimensionally interchangeable with the standard unshielded types in most sizes made by this company. The double-shielded series bearings are of slightly increased width over dimensions for standard miniature ball bearings. The protection is provided without any increase in torque over unshielded bearings.

The shields are recessed to avoid interference with shaft shoulders or housings, allowing freedom in tolerances. The shields are removable for bearings relubrication or inspection.

Resembling small saucers with center holes, the shields on the outer circumference fit into a recess in the outer race of the bearing and are positively positioned by a retaining snap ring. The inner circumference of the shield is precision fitted close to the shoulder of a relieved land on the inner race, permitting a clearance of less than 0.002 inch.



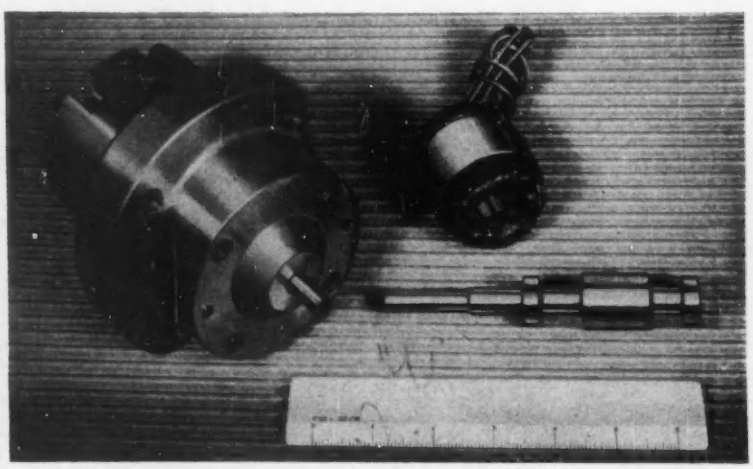
The shielded bearings are being produced in both chrome bearing steel and stainless steel; all shields are of stainless steel. The bearings are used in a variety of precision mechanisms such as miniature blowers, small electric motors, textile rollers and wherever foreign matter is present.

Miniature Precision Bearings, Inc., Keene, New Hampshire

High Speed, High Frequency Motors

High frequency motors for experimental and production applications are available in small, compact units for use at speeds up to 100,000 rpm, with higher speeds provided for special applications. One use has been on an internal grinding machine, capable of grinding small holes at a speed of 6,000 surface feet per minute.

The motor is mounted directly on the spindle and is the only moving part of the driving motor, since there are no brushes or moving contacts. The stator, carrying the motor windings, is cooled by a water jacket. Lubrication is provided by an oil mist carried in a stream of air. The motor is totally enclosed and remains clean indefinitely. Normally, pre-loaded precision ball bearings are used. However, for certain applications in the higher speed ranges, special air bearings are used where the spindle rotates on a cushion of compressed air. The latter construction is used for light loads, and has the added advantage of being almost completely friction-free.



A converter or an alternator must be used as the source of high-frequency current, and a single one can be used to drive a series of motors.

The Bryant Chucking Grinder Co., 360 Clinton Ave., Springfield, Vt.

CONTINUED ON PAGE 236

Greatest Giant
in Lockheed Aircraft's
"Hall of Giants" is this 8000-ton
Birdsboro deep-draw press...
the largest of its type in the world.
Its big main rams, in keeping with
their advanced design, are sealed
with LINEAR VEE-DAM Rings,
the most effective modern hydraulic
packing ever developed!

Foolproof to assemble
Leakproof in operation

LINEAR VEE-DAM RINGS

Cross sectional view

The unique design of LINEAR VEE-DAM Rings makes possible, for the first time, a split "V" ring packing that is really leakproof . . . ideal for hydraulic presses, pumps and pneumatic equipment.

A look at the close-up view of a VEE-DAM Ring will tell you why they seal so effectively. Those sturdy rubber dams, faced in opposite directions, are moulded into the groove hinge area of the ring, completely eliminating leakage between rings.

VEE-DAM Rings are easier to install because they don't demand the precise fitting that ordinary rings should have. And they last longer, too, because they seal perfectly tight with a minimum gland load.

Made of a choice of fabric reinforced synthetic rubbers, LINEAR VEE-DAM Rings are individually engineered for your application. Write or call LINEAR for complete information.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

Time Delay Relay for Pushbutton Operation

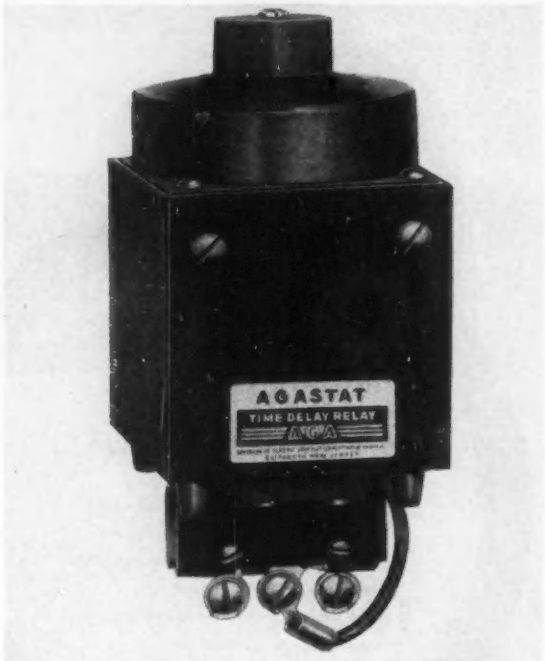
For control circuits requiring a time delay initiated by a momentary impulse, such as from a pushbutton or microswitch, a new time delay relay has been developed with a pneumatically-controlled time delay adjustable over a range from 0.1 sec to 10 min, or more. Like other relays developed by this company, it is a lightweight, compact unit, and may be used with standard a-c and d-c voltages.

The time delay is controlled by the flow of air through an orifice. Air used for timing is recirculated within the timing chamber, keeping it free of dust and other foreign material. The size of the orifice, which determines the length of time delay, is determined by a needle valve that can be easily adjusted by a screw on top of the timing chamber.

Called the NEH relay, it has a normally-closed auxiliary hold-in switch. In the de-energized state, the auxiliary switch contacts are held open by the operating spindle, which is an extension of the solenoid core. On energization of the coil, these contacts close immediately to keep the coil energized. The switch operates at the end of the time delay.

Including the auxiliary switch, the largest NEH is only $5\frac{7}{8}$ in. high and $2\frac{1}{2}$ in. square. It is available for all standard a-c and d-c voltages, in single-pole, double-throw, or double-pole, double-throw models. It is rated 15 amps at 115 v, 60 cycle, a-c.

Elastic Stop Nut Corp. of America, A G A Div., 1027 Newark Ave., Elizabeth, N. J.

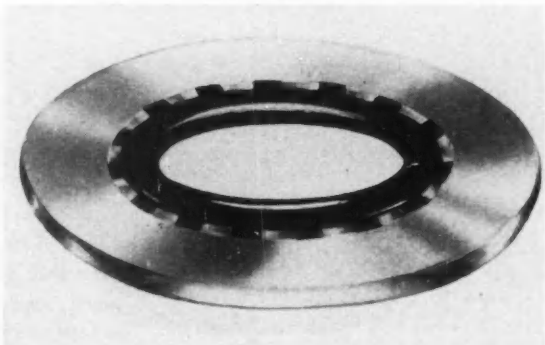


Simplified Bolt Seal for Gas or Liquid

A new sealing device for safe, sure, sealing of bolts and studs at either high or low pressure, gas, liquids, or air is constructed in one piece, and is non-directional. Called the Stat-O-Seal, it uses the principle of controlled confinement of the sealing gland, and cannot be assembled up-side-down.

The O-ring sealing gland is mechanically fastened to the metal retainer, which eliminates the possibility of failure of a chemical bonding agent. They do not require high fastening torques to seal, as there is always a full metal to metal contact without any load transference to the sealing gland. The seals are reuseable, and there is no loss of sealing from "cold flow." They are available in bolt sizes from —10 OS to $\frac{5}{8}$ inch.

Franklin C. Wolfe Co., Inc., 3644 Eastham Dr., Culver City, Calif.

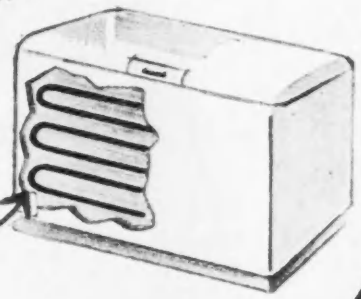


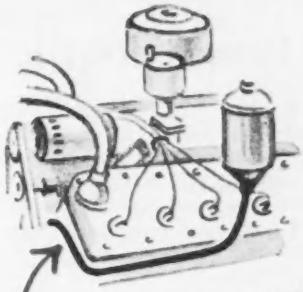
HAVING GOOD POSSIBILITIES in the field of copper base materials, a new alloy called Beryldur now available is described as filling the gap of property ranges existing between the two basic groups of beryllium-copper alloys; the high strength and the high conductivity groups. Beryldur has a low beryllium content of only one percent, about midway between the amounts contained in the high strength and high conductivity groups. To permit varying of the properties, the alloy also has good formability in the heat-treatable temper, one of the two tempers in which it is produced. The other is mill-hardened, which requires no heat treatment of finished parts. Present applications in the electromechanical field are for springs and switches. While presently only produced in strip form, Beryldur will soon be made as wire and rod. The Beryllium Corp., Reading, Pa.

CONTINUED ON PAGE 238

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*

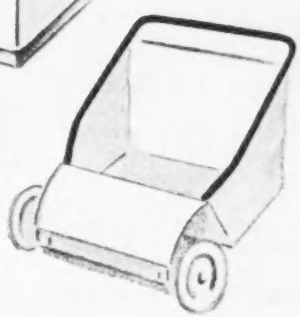
EVAPORATOR COIL FOR HOME FREEZER



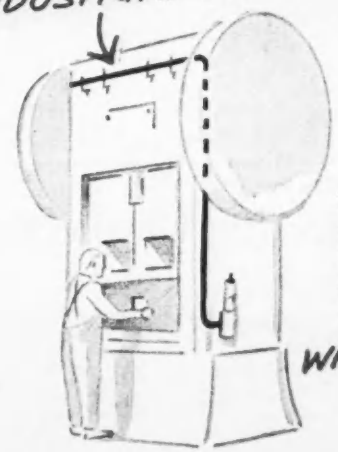


TIMING GEAR OIL LINE

FRAME FOR LAWN SWEEPER



LUBE LINES ON INDUSTRIAL PRESSES



REMARKS Perhaps you can improve your product -- with Bundyweld Tubing. For instance, you can end tubing-leakage worries. Or make your product lighter and stronger. Perhaps you can bring production costs down, too. Talk things over with our engineers.

WRITE to us for catalog or for specific information on your problem. BUNDY TUBING COMPANY, DETROIT 14, MICH.

Bundyweld Tubing

® DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile
Lightweight
Machines easily
Takes plastic coating
Takes plating
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: *Cambridge 42, Mass.:* Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., East • ***Bridgeport, Conn.:*** Korhumel Steel & Aluminum Co., 117 E. Washington St. • ***Los Angeles 58, Calif.:*** Tubesales, 5400 Alcoa Ave.

Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.

Fast, Versatile Pilot-Trace Recording Device

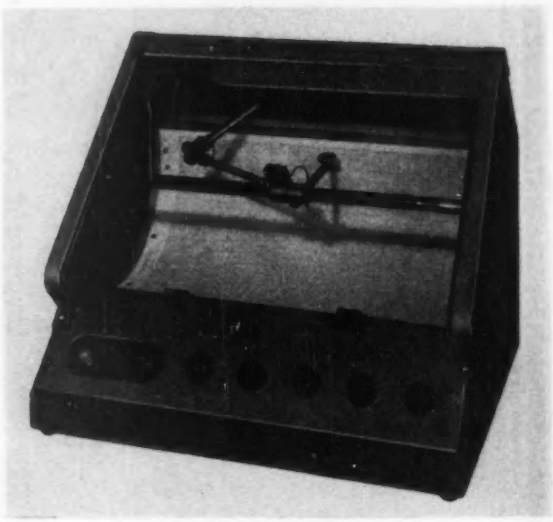
An X-Y plotter and recorder, a new two coordinate portable recording instrument for continuous curve or discrete point plotting, is equally useful for the display of digital information, the plotting of transistor characteristics or for calibration of such equipment as flow meters.

The X-Y plotter and recorder is designed either for desk use or for rack-mounting with the desk unit shown being 16 in. high, 19 in. wide and 16¾ in. deep. The unit is self-contained without cables, tapes, or lead screws.

The plotting surface is a stationary concave 120 deg cylinder and takes either 11 x 16½ in. or 8½ x 11 in. standard graph paper held down by magnetic clips.

Controls are located on the front panel and consist of dials for off-standby-4-quad. Four-quad operation accepts either negative or positive values on both axes. Origin may be shifted to any part of the chart. Zero offset and scale expansion of both axes is continuously variable over 10 to 1 range. The recorder is accurate to ±0.1 percent full scale (static) and operates on 150 w, 115 v, 60 cycles.

Accessories that can be ordered include punch card converter, decimal keyboard unit, analog or digital inputs, or polar coordinates input. The punch card input unit operates with IBM reproducing punches, types 513, 514, and 519, and gang summary punches, types 517, 523. The decimal keyboard is used for manual pointing plotting.



Librascope, Inc., 1607 Flower St., Glendale, Calif.

208 Contact, Quick Disconnecting Connector

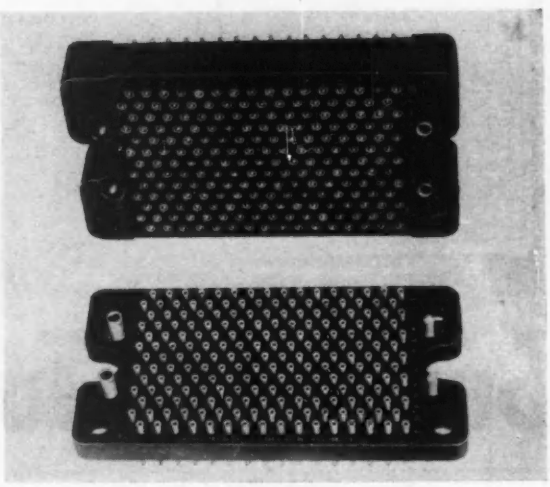
A new addition to the line of quick-disconnecting connectors is the QRE 208, having specially designed spring-loaded contacts that reduce disengagement forces.

Particularly suitable for rack and panel mounting, the floating contacts have 0.073 in. dia solder cups for No. 16 AWG, and assure proper "play" for self-alignment. Four heavy guide pilots and sockets serve to polarize mating connector parts.

Contacts and metal parts are precision machined and gold plated over silver for low contact resistance, prevention of corrosion and ease of soldering. Molded melamine bodies provide high dielectric, arc resistance and mechanical strength. One-piece construction eliminates unnecessary creepage paths and dust pockets.

Four $\frac{5}{16}$ in. dia holes are provided on both the plug and receptacle for mounting purposes. Voltage breakdown between contacts at sea level is 5,700 v d-c; and at 60,000 ft. altitude, 1,200 v d-c. Weight of plug, 13.9 oz; receptacle, 24.0 ounces.

Winchester Electronics, Inc., Glenbrook, Conn.



TO HANDLE APPLICATIONS of quick-connecting two-way shut-off couplings on smaller size pneumatic and hydraulic lines, the series HK ¼ to 1 in. line with additional sizes from ⅛ to ⅜ in. has been developed. When the series HK coupling is disconnected, a torpedo valve in the socket instantly contacts the valve seat, providing positive seal against the escape of gas or liquid from the socket end of the line. Simultaneously, an identical action seats the torpedo type valve in the plug end of the coupling to provide similar seal of the gas or liquid in the plug end of the line. All sizes in brass or steel. The Hansen Mfg. Co., 4037 W. 150 St., Cleveland, Ohio.

CONTINUED ON PAGE 240

TAYLOR ***Insulation (Fish Paper)***
is extremely tough . . . has high dielectric strength and excellent bending qualities . . . its hard surface resists abrasion from contact with rough spots in slots.

Want to make something of it?

Make it into armature slot insulation, armature end laminations, field coil insulation, metal box liners, washers, arc shields, formed slot wedges, formed specialties . . . or any other applications requiring excellent electrical characteristics. Color: gray.

Make it from sheets and rolls . . . or ribbon rolls for automatic machines.

SPECIFICATIONS

Thickness range . . . .003" to ⅛"
Finish. Calendered or uncalendered
Punching . . . . . Up to ⅛"
Sheet size . . . . . 36" x 90"

Roll width 36" in thicknesses of .005" through .090". Coils down to ¼" for thicknesses of .005" through .090".

PROPERTIES

Mechanical

Tensile Strength, psi

(Lengthwise)	14000 min.
(Crosswise)	6000 min.

Elmendorf Tearing Strength, grams

	*MD	*CD
.005"	100	120
.007"	190	220
.010"	250	300
.015"	375	450

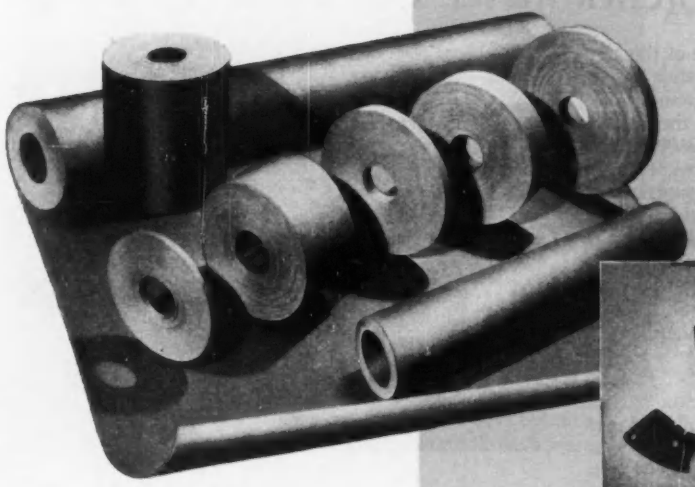
*MD—Machine Direction
*CD—Cross Machine Direction

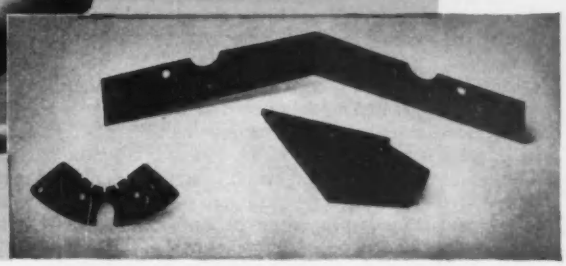
Electrical

Dielectric Strength, vpm
Short Time Test

.004"—.005"	200 min.
Over .005"—.015" incl.	300 min.
Over .015"—.040" incl.	250 min.
Over .040"—.060" incl.	175 min.

Arc Resistance, seconds 100





Make it easy for yourself the next time you are buying insulation. Call your Taylor Engineer . . . he will be glad to help you select the Taylor Insulation that will best fit your needs. Also ask him for samples of our other grades of vulcanized fibre—Commercial, Bone, Super White, Abrasive and Built-Up —as well as Taylor *Phenol, Silicone and Melamine Laminated Plastics* . . . see where they can fit into your design plans.

Taylor Fibre Co., Norristown, Pennsylvania—La Verne, California

TAYLOR
Laminated Plastics
Vulcanized Fibre

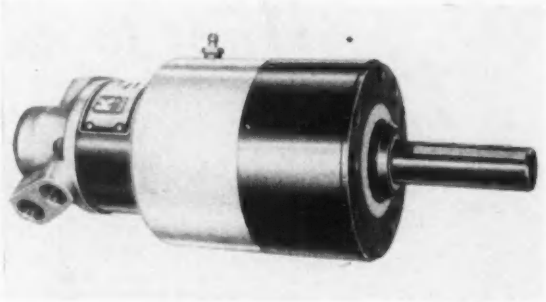
New Air Motors Have Low Air Consumption

Air motors featuring an axial piston design that results in low air consumption are available in ratings from ½ to 2¾ hp, in twelve combinations of speed and torque to meet a variety of industrial applications. The range of starting torque for these motors is from 1.5 to 82 ft-pounds.

Air consumption varies from 21 cfm in the smallest to 83 cfm in the largest size motor, the low figures resulting from more efficient use of air supply which is possible with the axial piston design.

This feature, together with immunity to burnout when stalled, suits the new motors to such applications as valve closing, in agitators, tilting tables, and as variable speed drive for overhead cranes.

Continuously variable speed control, from zero to full, plus freedom from spark hazard, make the series 70A air motors suited for production applications. Braking action is possible by regulation of exhaust air. Consistent torque output is achieved on low and high air pressure. Motor runs just as well in either direction with a 4-way valve.



Side and end air intake ports are provided on the 3 larger series of motors, permitting close quarter installations, and giving added convenience for piping connections.

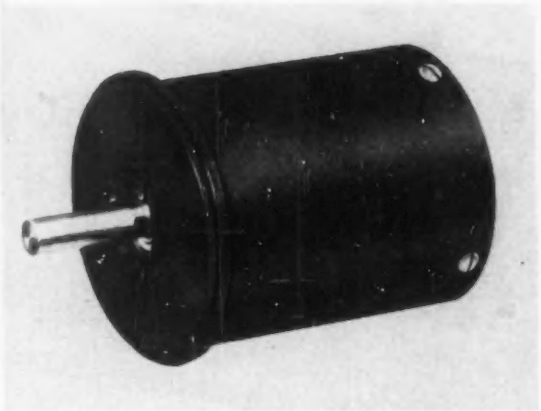
Keller Tool Co., 4800 Hall St., Grand Haven, Michigan

Rugged, Ten-Turn Potentiometer Has Good Linearity

Standard linearity of 0.02 percent is a feature of this new rugged potentiometer now available in resistance ranges from one-thousand to one-hundred-fifty thousand ohms with a resistance tolerance of 1 percent. In the middle resistance range and above, linearities better than 0.02 percent can be furnished. The unit has ten full turns of travel, plus ninety degrees mechanical and electrical overtravel at each end. The resistance element continues through the overtravel and can be tapped in that interval. Each unit is supplied with a continuous linearity curve calibrated against a standard accurate to 0.001 percent.

Starting torque is 0.5 ±0.3 in.-oz at 20 C, and running torque is 0.3 ±0.2 in.-oz at 20 C. Moment of inertia is 25 gram cm^2. The maximum velocity is 200 rpm.

Precision mechanical construction includes stainless steel ball bearings and shaft, and an anodized aluminum case. The unit is rust-proof, contains no fungus nutrient, and may be operated over a wide temperature range. It is impervious to torgue damage in normal use because of a built-in traveling nut type limit stop indepedent of the wiper arm.



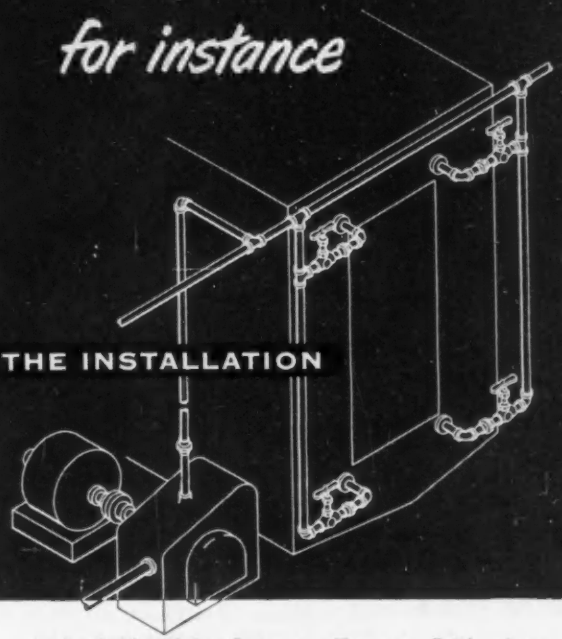
Birklan Corp., 200 E. 3rd St., Mt. Vernon, N. Y.

TWO TYPES OF ALKALINE BATTERY ASSEMBLIES can be sliced like a package of mints into various combinations of cells to provide different voltage requirements. Both battery assemblies (VS087 and VS088) are 21 v special-purpose types. Each contains 15 individual 1.4 v crown-type alkaline dry cells encased in a plastic sleeve. Each cell is indicated by a pair of ridges which are formed in the plastic sleeve by the edges of the metal caps of the cell. Various power requirements, from 1.4 v to 21 v, can be obtained by slicing a section of the battery having the necessary number of cells. Radio Corp. of America, Tube Dept., Harrison, N. J.

FLUORLASTIC GASKETS, a new composite gasket material made of silicone rubber completely enveloped in Teflon or Kel-F, combine the good high and low temperature properties and compressibility of silicone rubber with the chemical inertness of Teflon and Kel-F. The silicone core is available in solid stocks of various durometers and in silicone sponge. The envelope ranges in thickness from 0.0025 to 0.030 in. Strip-type gaskets in various shapes, in lengths up to 96 in. and widths of 4 in., are available with both Kel-F and Teflon envelopes. The Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.

CONTINUED ON PAGE 242

There's a Big difference–even in Small Valves ...on Spray Driers, for instance



At the Golden Valley Creamery, Newman, Calif., where Crane Bar Stock valves replaced original lead regulator valves on spray process milk driers. They handle hot milk from high pressure pumps, at 2000 to 3000 psi, at a temperature of 180° F.

VALVE SERVICE RATINGS

SUITABILITY: Couldn't be better

FEATURES: Solid bar stock construction

MAINTENANCE COST: None

SERVICE LIFE: Still top performance after 5 years

OPERATING RESULTS: No shutdowns for valve repairs

AVAILABILITY: Crane Catalog item – No. 222-SS

THE CASE HISTORY

The original equipment valves on these driers had a short life. They started failing quickly . . . couldn't be regulated . . . interrupting control of the process. Shutdowns for valve repairs were excessive; maintenance costs increased. The trouble was the stem threads were always stripping.

Not until all original valves were replaced with the sturdy, precision-made Crane 18-8 Mo Bar Stock valves, was the trouble completely stopped. That was more than 5 years ago. The Crane valves are still in the lines, holding down maintenance costs year after year, helping keep the plant at peak efficiency.

THE VALVE

You can see and feel the high quality of Crane Bar Stock valves. They're sturdy, compact and precision-crafted from solid steel, Exelloy, or 18-8 Mo, for cold working pressures up to 3000 psi. Sharply tapered disc gives closest flow regulation. Wide seating surfaces stay tight, resist wire drawing and cutting. You can't find a better valve for regulator leads, orifice meters, by-passes, and many similar services. Sizes up to 1-in. See your Crane Catalog or Crane Representative.

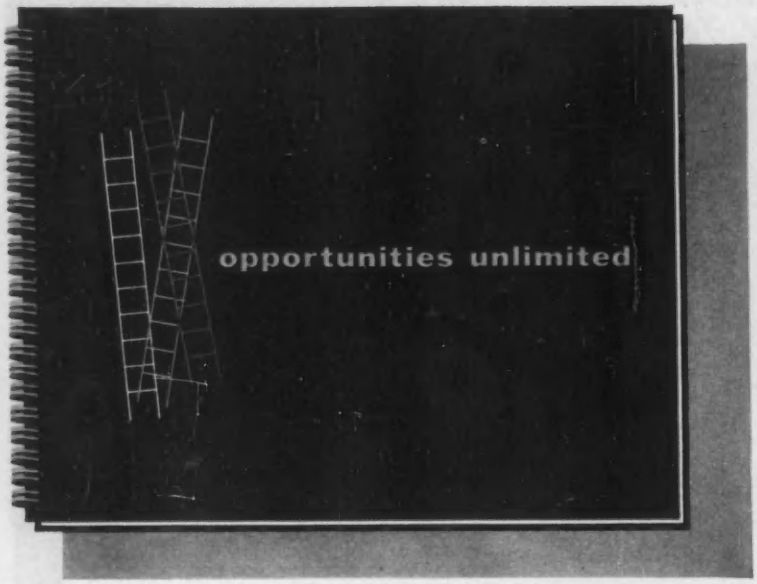
THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES · FITTINGS · PIPE · PLUMBING · HEATING

if you design or purchase metal parts



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Here for the asking — without one bit of obligation — is a dynamic book that tells and shows quickly and dramatically the unlimited opportunities which The Crosby Company offers in metal parts development and fabrication.

It carries a valuable, profit-making message: (1) to industries of every size, description and location. (2) for products of innumerable uses, sizes, weights and materials. (3) for meeting requirements and conditions of the most challenging nature.

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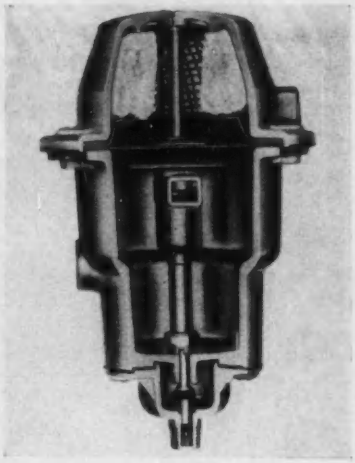


Automatic Air Line Moisture Separator

An improved separator is said to assure unlimited service life even under the most unfavorable conditions, separating and discharging all non-gaseous contaminants from any air line without attention by plant personnel. Sizes available are for $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ in. air lines.

Using stored air pressure for actual discharge of accumulated water and sludge, the separator uses so little air that pressure drop is negligible, regardless of application. The device has only one moving part, actuated by a flexible diaphragm. A replaceable filter serves to trap any moisture that might escape the main condensation chamber.

The separator is so designed that condensations collect in a sump between actuations of the line it serves, and use of a tool on the lin triggers the discharge of the accumulation without using any air required for the tool.

Wilkerson Corp., 3387 S. Platte River Dr., Englewood, Calif.

Rubber Vaned Pump For Water Circulation

A new industrial pump with scoop rotor and rubber roller-type vanes has been designed for continuous water recirculation requirements, and is engineered for continuous duty service through the use of sealed, permanently lubricated ball bearings. An additional feature is a pressed fit of the stainless steel shaft into the inner ball bearing race to restrict lateral movement of the rotor, minimizing end thrust wear within the pump. Friction losses are held to a minimum. A continuous

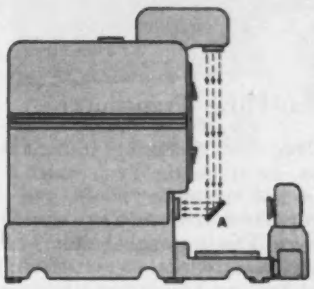
(*Advertisement*)

Plain Pointers on Projection

AMONG the definitions listed by Webster for the adjective *universal* is: "adapted or adaptable to all or to various uses, sizes, shapes, et cetera"—a definition we like to feel applies to Kodak Contour Projectors.

Admittedly, we make two projectors, one for routine inspection gaging (the low cost of which might surprise you) and a second for toolroom use affording measurements to "tenths." Optically, however, these two instruments are one. And it's their optical system which makes them truly "universal."

Back in the early days of design, our engineers set out to provide in a single contour projector light sources both for horizontal and for vertical shadow projection. They also developed the unique Kodak Surface Illuminator, a self-contained light source which affords surface projection in either plane. Their reasoning was economic. By combining these features, the instrument could be easily adapted to a wide range of parts; the more uses to which the projector might be put, the sooner it would pay for itself in the shop.

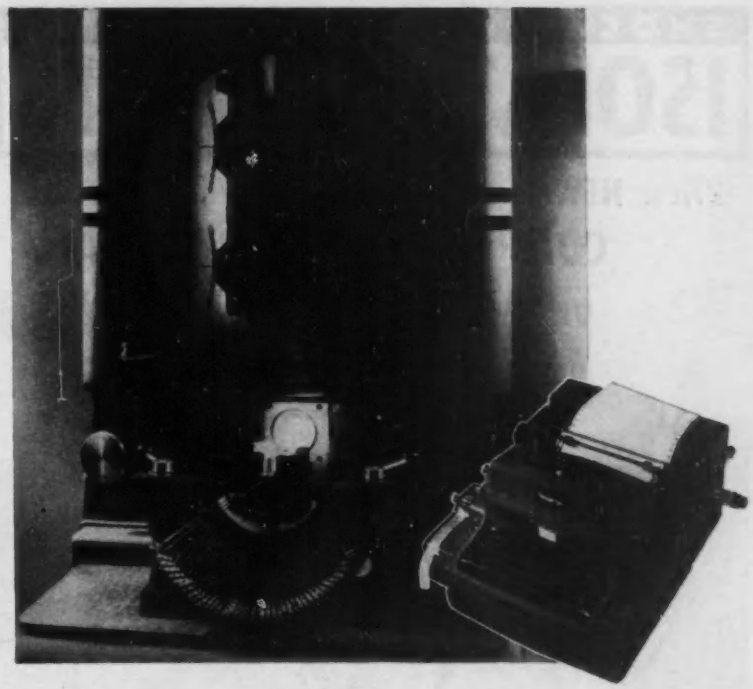


Above drawing illustrates how vertical light source is utilized. With part on a glass staging platform, image is reflected by mirror (A) into optical system of projector.

Nothing has happened since the design stage to shake us in this belief. However, we have been somewhat surprised by some of the highly ingenious ways in which our projectors are used: as in the case of the typewriter fixture (illustrated in our advertisement at the right), where the surface illuminator yields a simultaneous plan and profile view of the type bar face.

Equally ingenious, if not more so, is a device which employs both the horizontal and vertical light beams to simultaneously project the shadow image of a shaft and a reticle scale for gaging its tolerances. A description of this application, which runs to more words than space here affords, is available on request from the Special Products Sales Division, Eastman Kodak Company, Rochester 4, N. Y. Just ask for the folder on the new, universal shaft checking fixture.

Applications such as these have opened the eyes of many engineers to the fact that inspection by optics today has overcome traditional limitations. In the best sense of Webster, contour projection may be "adapted to various uses, sizes, shapes, et cetera." And to the solution of various problems in inspection and precision measurement, including, perhaps, your own.



This "3-D picture" showed the way to cut aligning time 25%

What you see here on the Kodak Contour Projector is both the *front* and *side* view of a typewriter type bar—a picture that helped reduce aligning time 25% at Commercial Controls Corp., manufacturers of tape-controlled Flexowriters and Justowriters.

Light reflected from the surface of the type character provides an image for rapidly checking horizontal and vertical alignment of the letter. Simultaneously, mirrors in the special holding fixture project a profile image of the type—yield an accurate check of the desired position of the letter as it will contact the platen. Only the Kodak Contour Projector's unique surface illuminator makes possible this combined plan and profile view.

Alignment of type is a critical factor on these automatic machines which type at 100 words a minute and must produce copy for printing reproduction. Until recently, Commercial Controls had to perform this inspection operation during final assembly. Now, this new gaging technique has made it possible to inspect the type bars immediately after their removal from the soldering jigs. Each bar is quickly moved into place and compared with the tolerance lines of the chart-gage on the screen. Alignment of letters is held to a tolerance of ±.0002", contact to ± .0015". And, by catching errors at this point, aligning time has been cut 25%.

Perhaps the speed, precision, and economy of optical gaging can help you solve a difficult inspection or measurement problem. There is a field representative in your area who will be glad to discuss your problem with you. You can get in touch with him or obtain a copy of the booklet, "The Kodak Contour Projector," by writing to:

Special Products Sales Division
EASTMAN KODAK COMPANY
Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Optical Gaging

A new sound movie, Optical Gaging, shows how to simplify complex inspection problems. We'll tell you how to get it for a showing.

Kodak

SHOCK – VIBRATION – NOISE

ISOLATION NOTES

These **NEW** *Product Bulletins give* **YOU**

COMPLETE ENGINEERING DATA on ALL-METL BARRYMOUNTS

Here's what's in them for **YOU:**

1. Transmissibility curves showing performance under test conditions of JAN-C-172A.
2. Curves showing reduction of transmitted acceleration and displacement.
3. Curves showing how changes in loading affect transmissibility at resonance and natural frequency for vertical motion.
4. Curves showing effect of high and low temperature on isolator performance.
5. Shock-characteristic data, including curves showing vibration isolation after 15g shock test.
6. Application data, including curves that show you how to choose isolators for unsymmetrical loads.
7. Dimensioned drawings of unit isolators, channel pairs, and mounting bases.
8. Detailed data on the construction, operating principle, and weights of mounts and bases.
9. A complete list of load ratings and catalog numbers for unit isolators, channel pairs, and bases.

These are the first really comprehensive bulletins on knitted-wire vibration isolators. To get your FREE copies, ask for Barry Product Bulletins 534 and 536. *And, if you have a special problem, count on getting the right answer from our Field Engineering Service.*

THE **BARRY** CORP.

730 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

Atlanta Baltimore Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington

5,000 hr test, with water at 40 lb pressure, produced no measurable wear in the Hy-Car rubber rollers or the pump case.

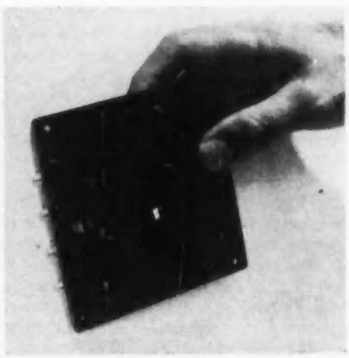
The model 4300 pump impeller is self-lubricated by water and will deliver approximately 7 gal per min at 50 lb pressure and 1,750 rpm. Pressure range is from 0 to 75 psi. The new pump is furnished with $\frac{3}{4}$ in. ports, and recommended speeds are to 1,800 rpm. Weight is $4\frac{1}{2}$ pounds.

Hypro Engineering, Inc., 404 N. Wash. Ave., Minneapolis 1, Minn.

Heat-Flow Transducer

Heat-flow measuring instrumentation, based on the new model 200 heat-flow transducer shown, can directly drive indicating or recording meters. This is possible because of the high linear electrical output relative to heat-flow gradient across the transducer. The high electrical output results from a large area-density of silver-constantan thermocouple junctions whose output can be connected in various physical and electrical configurations depending upon the requirements.

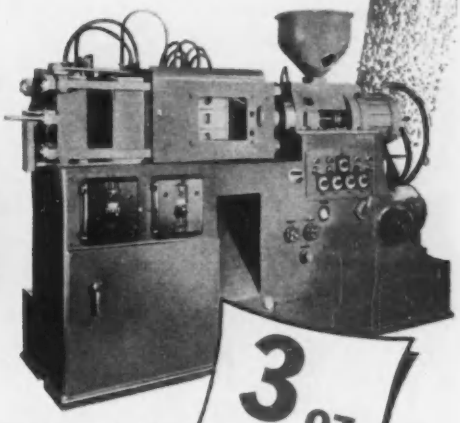
Based on a unit $\frac{3}{64}$ by $4\frac{1}{2}$ by $4\frac{1}{2}$ in., containing from 180 to 720 junctions plus a thermocouple to check ambient temperatures, the transducers are made in a range of sensitivities up to 6 btu/ft²/hr/mv. Each transducer weighs approximately one ounce and has ther-



Fellows is *Fastest* in either capacity!

Model 5C-8

- More rapid cycling—up to 7 cycles per minute dry run.
- More ounces per shot—up to 9 oz. polystyrene, 10 oz. acetate.
- More pounds per hour—up to 100 lbs. on polystyrene.
- 'Beefed-up' press for solid clamping, simple, fast mold height adjustment.
- Open accessibility for fast maintenance.
- Grouping of controls, fully automatic operation.



Model IB-3-15

- 6, 8 and even 10 shots per minute.
- Full automatic operation—one operator can tend 3 machines.
- 45 pounds per hour plasticizing capacity.
- 20,000 psi injection pressure for pin-point gating.
- 100% operating ease—grouped controls, simple set-up, fast warm-up.

Your first step to more profitable molding is to get in touch with Fellows at the nearest office listed below.

Fellows

injection molding equipment

THE FELLOWS GEAR SHAPER COMPANY, Plastics Machine Division, Head Office and Export Department, Springfield, Vermont
Branch Offices: 323 Fisher Bldg., Detroit 2, Michigan • 5835 West North Avenue, Chicago 39, Illinois • 2206 Empire State Bldg., New York 1, N. Y.

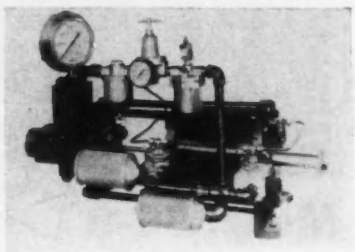
mopile and thermocouple terminals brought out to one edge.

Among the specific applications of the new transducers are total-hemispheric and net-exchange radiometers, portable heat-flow meters, and soil heat-flow recorders.

Beckman & Whitley, Inc., 925 San Carlos Ave., San Carlos, Calif.

Compact Air Driven Hydraulic Pump

This air driven hydraulic pump, available in single or double-acting models, is a simplex horizontal type, and meets demand for small volume capacity at medium and high pressures. It develops up to 20,000 psi operating on 90 psi air supply, is a self-contained



machine complete with air filter, regulator, lubricator and hydraulic pressure gage, and can be operated wherever air pressure is available. The unit simplifies the operation for such applications as testing tubing, valves and pressure vessels, as well as supplying power for small molding presses.

The Aldrich Pump Co., Allentown, Pa.

New Instrument Simplifies Valve Setting

Called the Valve-Gapper, this new precision instrument utilizes a new principle in setting valve clearance, or gap, on engines with overhead valves. The device measures the travel of the valve rocker arm prior to contact with the valve stem. This measurement is transmitted to a dial indicator gage graduated in thousandths of an inch. The dial permits a visual setting of valve clearance regardless of wear or pitting of the valve rocker arm.

Hydraulic valve lifters can also be visually checked with this instrument. It is placed on the valve rocker and with the engine running, the smallest gap will register.

In setting valve gap, the instrument is positioned on the valve rocker arm with the base resting on the valve

LEADING AIR CYLINDER PRODUCERS, TOO, USE OR RECOMMEND

Norgren micro-fog

to assure best lubrication

PRODUCTION INCREASED 1000%

A Norgren Air Pressure Regulator, Filter and Micro-Fog Lubricator safeguard the high speed, automatic operation of this compact unit made with 4 Bellows Air Motors and a Bellows Rotary Feed Table. It handles 4 stages in the assembly of valve parts with a production gain of 1000% over the previous methods used.

For better operation and long wearing life, air cylinders require a dependable, automatic supply of oil distributed uniformly as a fine film over the entire inner wall. That's why leading producers of air cylinders, such as **Bellows** and many others, use or recommend Norgren Micro-Fog. It produces an extremely fine and uniform airborne oil fog, distributes it evenly, provides exact control and is automatic.

FLEXIBILITY IN DESIGN

Norgren Micro-Fog lubrication systems have enabled hundreds of other manufacturers to obtain greater flexibility in product design and plant layout; improve equipment performance; and reduce maintenance costs.

If you are manufacturing or using air operated equipment or have a lubrication problem with high speed spindles, bearings or gear boxes ***be sure the right people in your plant have complete data on Norgren Micro-Fog.***

WRITE TODAY

C. A. Norgren CO
3428 So. Elati St., Englewood, Colo.

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 25 YEARS

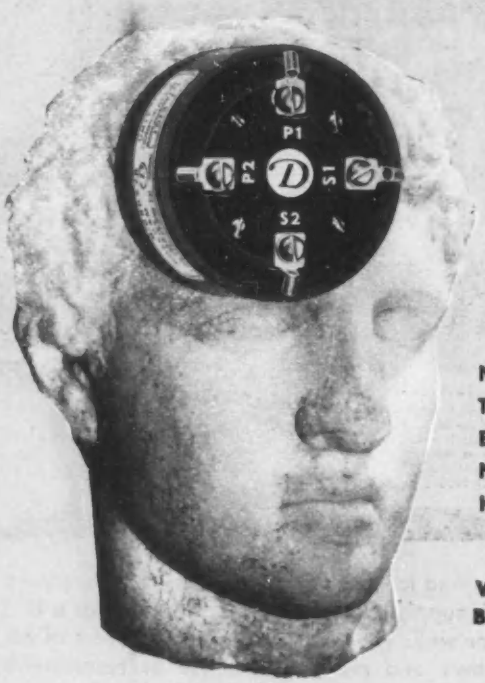
Valves • Filters • Regulators • Lubricators • Hose Assemblies

Specialized Lubrication Engineers in Principal Cities
See the yellow section of your telephone directory.

A new tool for angular measurement

Doelcam

POSITION INDICATOR Microsyn



No electrical contacts
True linearity
Extreme resolution
No reaction torque
High sensitivity

Write for Bulletin M3

IN INDUSTRIAL AND MILITARY applications, this small electromechanical signal generator transforms angular displacement into an electrical signal. It provides a linear output and a resolution to less than 0.01°. Tested and perfected as a standard military component for use in gyro instruments and computers, the DOELCAM Microsyn Position Indicator is now finding wide application in the industrial fields of process control, data transmission, measurement of mechanical variables and analog computation.

Doelcam CORPORATION

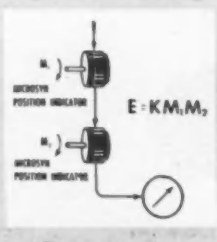
SOLDIERS FIELD ROAD, BOSTON 35, MASS.
West Coast Office: 304 Tejon Pl., Palos Verdes, Calif.

Instruments for Measurement and Control

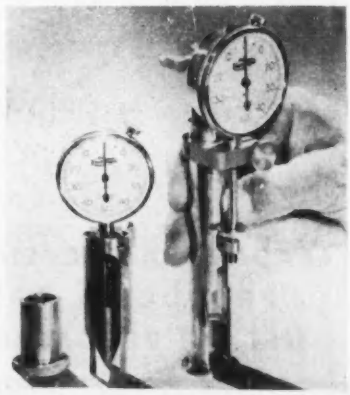
Gyroscopic Instrumentation · Servomechanisms
Synchros · Microsyns · Servo Motors

Data Transmission

Process Control



Computation



keeper, and the movable bracket hooked on the edges of the valve rocker arm. As the rocker arm moves toward the valve stem, the bracket moves with it until contact is made. This movement is registered on the dial indicator. As soon as the rocker arm contacts the valve stem, the entire tool moves downward with the valve. The only movement registered is that of the rocker arm prior to contact with the valve stem.

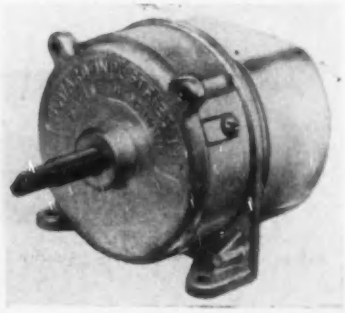
Shown in the illustration is the model 201 set, which includes: the micrometer plug gage at left; the injector timing attachment with dial indicator, center; and the basic tool for setting valve gap and balancing the fuel injector racks on GM-71 series diesel engines.

P & G Mfg. Co., 2262 N. Albina Ave., Portland 12, Ore.

Small Shaded Pole Motor Has Wide Usage

Having wide usage in vending machine and other gear-motor applications, the new model 3000 EMC shaded pole motor shown is the first motor of its type to be completely housed in an aluminum motor housing. The motor is also available in several variations, with or without gear units.

Power output of model 3000 pro-



IMPACT TESTS · METALLOGRAPHIC TESTS
MAGNA-FLUX TESTS · RADIOGRAPHIC TESTS
TENSION TESTS · HARDNESS TESTS
ULTRASONIC TESTS
TO MEET YOUR REQUIREMENTS

Standard Steel's Modern Laboratory Control With Thorough Testing is one of

SIX REASONS why you should always call Standard Steel for rings and flanges:

1 **TESTING**—radiographic tests, tensile tests, hardness tests, ultrasonic probing of internal structure, etc.

2 **QUALITY STEEL**—maintained constantly through production of own steel by acid process.

3 **UNIFORMITY**—assured by precise control of forging and rolling operations.

4 **CAPACITY**—unsurpassed ability to produce weldless rings all the way up to 144″ O.D.

5 **EXPERIENCE**—produced by skilled workmen with 20 to 40 years experience.

6 **FAST SERVICE**—a vital factor in the continuing growth of Standard Steel for over 150 years.

STANDARD STEEL WORKS DIVISION

Burnham, Pennsylvania General Offices: Philadelphia 42, Pa.

BALDWIN BLH LIMA-HAMILTON

Offices in Principal Cities

BALDWIN-LIMA-HAMILTON

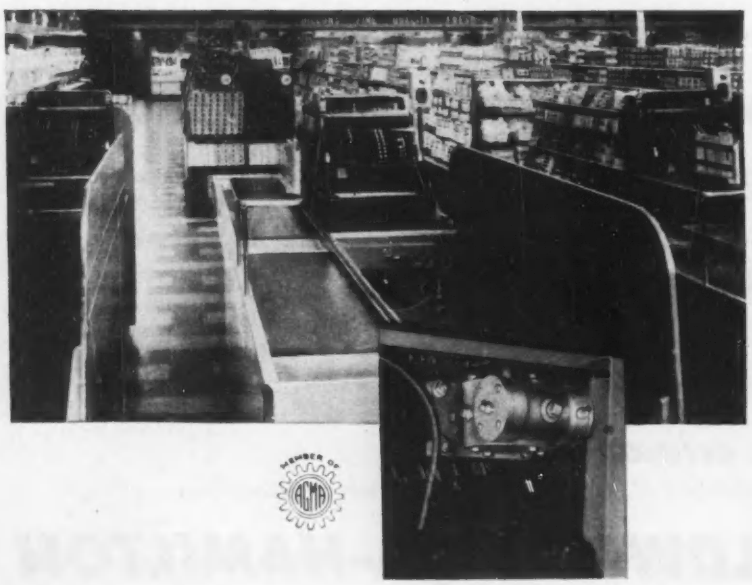
Carrying meats, vegetables and groceries past the cash register to the wrapping clerk, at 18 ft. per minute, check-stand conveyors send super market shoppers quickly on their way in Dillon's 25 Kansas food stores.

Depended on to turn each of the grocery-laden belts at correct speed is a Winsmith Speed Reducer, special assembly Model 2B, with a reduction ratio of 48:1. "...the only reducer which would fit in the limited space beneath the check-out counter and give proper operation," states J. S. Dillon and Sons Food Stores Co., Inc.

Compactness, coupled with ruggedness and dependability, have made Winsmith Speed Reducers essential components of numerous types and makes of essential equipment. Worm, helical and differential units are promptly available within the range of 1/100 to 85 hp in 1.1:1 to 50,000:1 reduction ratios.

Request catalog 148 for details.

WINSMITH, INC.
111 Eaton St.
Springville (Erie County), N. Y.

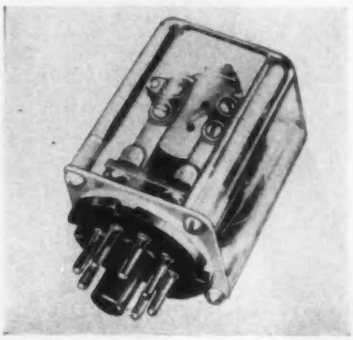


duces up to 120 in.-lb, or without gear unit, hp ratings to 1/200 hp at 3,400 rpm. Other features include thermal overload protector (optional) and fan (optional). Gear ratios up to 2,000:1 are available. It can be mounted horizontally in any direction. Gears are lifetime lubricated, and the motor is equipped with sleeve bearings.

Howard Industries, Inc., Racine, Wis.

Plate Circuit Plug-In Relay

Intended for use in original equipment using photo-electric cell control or similar electronically operated circuitry, this new plate circuit, current actuated plug-in relay is enclosed in a clear polystyrene dust cover. The

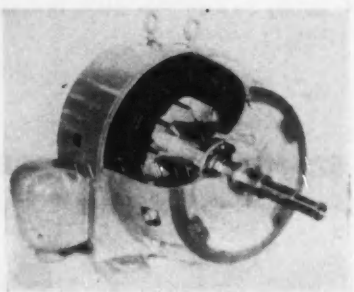


contact rating is 2 amp, 115 v, a-c non-inductive load. The operating coil power is 125 milliwatts per movable pole with a contact pressure of about 10 grams. It is also available in a number of additional ranges.

Potter & Brumfield, Princeton, Ind.

Close-Coupled Pump Motors to 50 Hp

Available as high as 60 hp and designed specifically for use with centrifugal pumps, this motor, type SCB, eliminates shaft alignment or pump mounting problems by supporting the



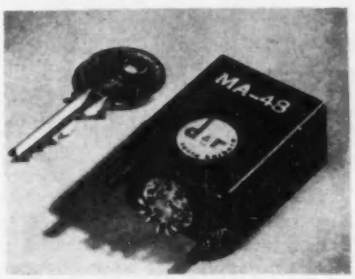
pump on its NEMA style C registered mounting bracket. A step shaft, with special diameter, shoulder and tapped hole for mounting the impeller, has all ground diameters for precision assembly and sealing against leakage. Bearings are ample to carry the thrust of centrifugal pumps.

A solid, closed flange on the style C adapter bracket prevents entrance of the pumped liquid into the motor. To offer further protection, a corrosion-resistant, bronze slinger is mounted on the take-off shaft for deflection of any packing leakage.

U. S. Electrical Motors, Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

Miniaturized Magnetic Amplifier

High power handling capability for their size and weight is the main feature of a new line of miniaturized magnetic amplifiers. Through the use of special core materials, winding techniques, and mountings, coupled with the use of high-frequency a-c power,



it is possible to get fast response time, and high power handling capability in a small, light-weight unit.

The unit illustrated, model MA-48, weighs only 3 oz, yet delivers a power output rated at about 25 v, with rapid response time and high power gain.

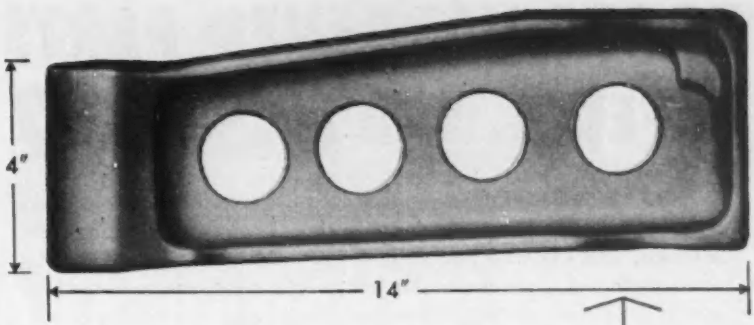
Also available from this company is a line of miniaturized 4,000 cycle and 2,000 cycle magnetic amplifiers, in addition to a standard line of 400 cycle and 60 cycle units.

D & R, Ltd., 402 E. Gutierrez St., Santa Barbara, Calif.

Small Frame, Fluid-Shaft Motors

With a new range of fluid-shaft motors, in frame sizes as low as No. 203, is included a newly-designed midget fluid coupling for use on ratings from ½ hp through 1 hp.

Reduced size is possible as a result



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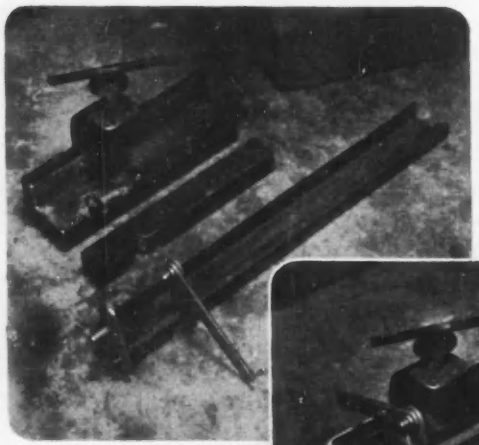
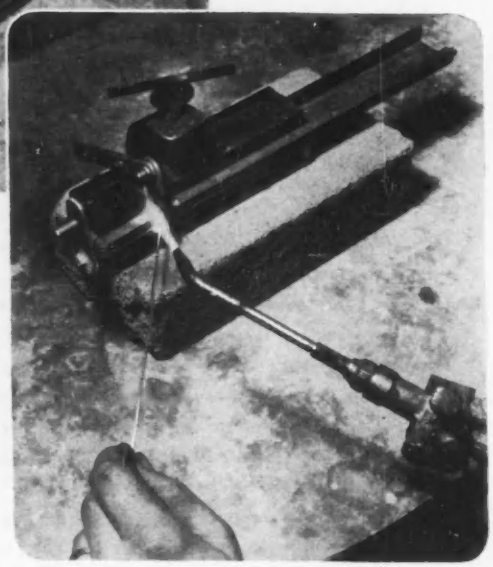
With EASY-FLO — the low-temperature silver brazing alloy — you can braze parts that have been hardened, without appreciably affecting their hardness. That's because EASY-FLO's low brazing temperature, plus its remarkably fast penetration the instant this temperature is reached, greatly reduce the amount of heat and the heating time required.

By using copper bars as "chill bars" to help dissipate the heat, you can make doubly sure of preserving the hardness of the parts.

HERE'S AN EXAMPLE—a hardened steel part of a ticket vending machine, brazed for the General Register Corp. by Salkover Metal Processing of New York, Inc., Long Island City, N.Y., metal joining specialists.



At left is a hardened steel machine part and the two brackets that are brazed to it; also two copper chill bars, one of which has a clamp screw.



At right you see the hardened assembly clamped between the two chill bars and the arm bracket being brazed to it with 3/64" EASY-FLO wire. Clamping assures the close contact needed for good conduction of heat to the chill bars. Both brackets are brazed with no appreciable change in the hardened surfaces.

FIND OUT WHAT EASY-FLO BRAZING WILL DO FOR YOU

BULLETIN 20 gives full details about the remarkable metal joining strength, speed and economy manufacturers everywhere are getting with EASY-FLO low-temperature silver alloy brazing. Write for a copy today.

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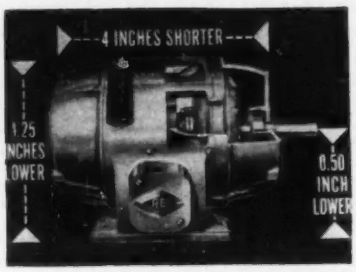


of this new development. In a ½ hp unit in a No. 203 frame, the overall length is shortened 4 in.; the height 1¼ in., and the D dimension (floor to shaft centerline) ½ inch.

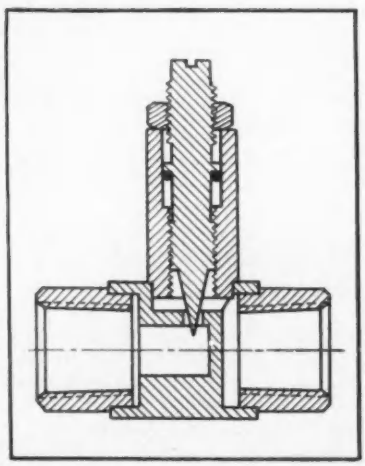
The internal coupling feature reduces the space required by separate units. Smooth load acceleration; protection against equipment jamming; and an ability to start heavier loads than standard motors of the same horsepower, are additional features of the fluid-shaft motors.

These motors are available in standard frame sizes from No. 203 through 326, and in ratings from ½ hp through 15 hp. These units are also available as standard equipment in combination with through-shaft magnetic brakes or gear reducers.

Reuland Electric Co., Alhambra, Calif.

Needle Valves for Precise Fluid Flow Control

This new needle valve, with a copper-brazed body, is designed to limit or restrict flow in a line and is especially applicable when accurate amount of flow is required. The needle valve, which can also serve as a gage snubber, is designed to hold adjustment and not be deflected by pressure. The locknut loads the stem in the same direction as the pressure



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FEDERAL FAWICK CORPORATION
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For further information on Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin 400-A.

Fawick E Slip Clutch

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LONG LIFE—LOW MAINTENANCE

FAWICK Airflex

INDUSTRIAL CLUTCHES AND BRAKES

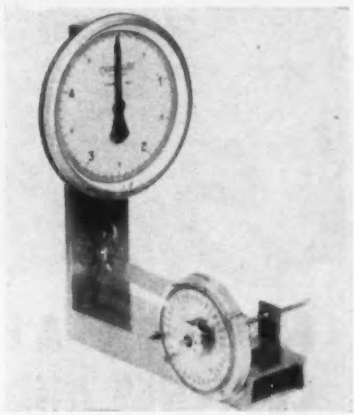
and the threads are always loaded. Flow through these valves is adjusted from a few drops per minute to full capacity. They can also be closed without leakage. The O-ring packing used on the stem is the only packing used.

The copper-brazed steel bodies have burst pressures that exceed 10,000 psi. Available in three models, the needle valve is designed for oil and to fit $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ in. pipe sizes.

Fluid Controls, Inc., Mentor, Ohio

Medium Capacity Torsion Spring Tester

Accurate to within 1 percent, the new model 942 medium capacity torsion spring tester, was designed to test right and left hand torsion springs. It is available in capacities from 5 in.-lb up to 100 in.-lb, or the equivalent in the metric system. The dynamometer



dials are graduated in increments of from 0.02 in.-lb. to 0.5 in.-pounds.

The illustration shows the tester set up to test left hand springs. The deflection dial is removed to the rear operating shaft for testing right hand springs.

John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.

Snap Action Switch for Vibration Applications

A new "hammer-blow" snap action switch has been developed for use in severe vibration applications or for accurate control with slow moving cams and pressure operated devices. Tests have shown it to be efficient for use on heavy presses, earth-moving equipment and aircraft. The switch maintains a high contact pressure of at least 45 grams until the instant the

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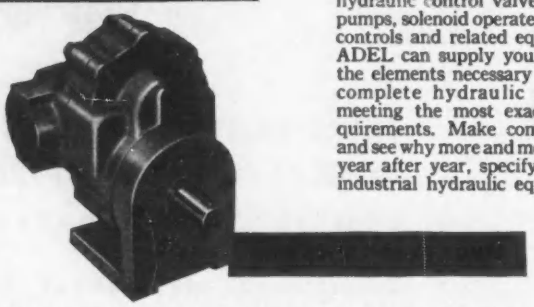

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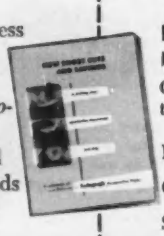

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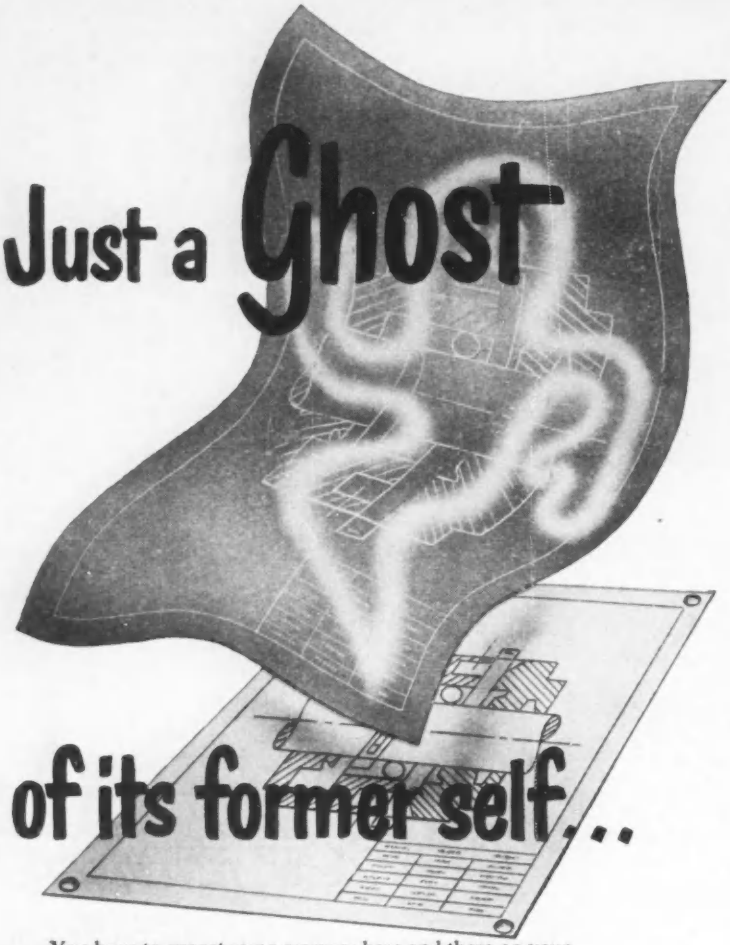

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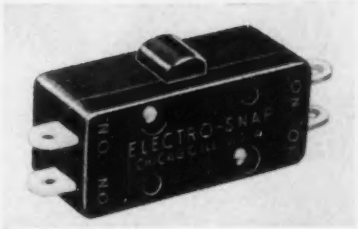


contacts snap over. The contacts snap over with hammer-blow force of 150 to 200 grams contact pressure, reducing arcing and increasing electrical capacity.

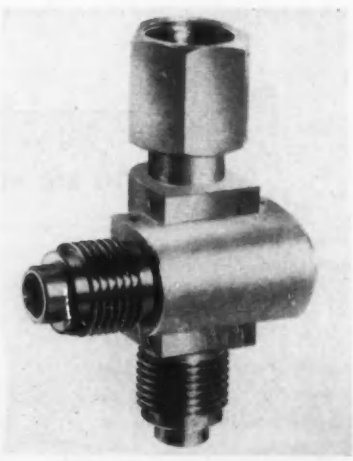
Rated at 15 amps, 125/250 v a-c or 30 v d-c, the switch is a single-pole, double-throw type with four terminals and two separate circuits in a space-saving size of $1\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$ inch. It is also available in a reset model which, when actuated, holds the contacts in one position until a second button is pushed. This model is recommended for over-pressure and other over-limit safety uses and for reversing control.

The switch may be used with or without an actuator, depending on the over-travel required. A variety of actuators including lever, leaf, pushbutton, and toggle types are available.

Electro-Snap Switch & Mfg. Co., 4220 West Lake St., Chicago 24, Ill.

Adaptor for Flexible Shaft Connections

This new Circle Ess, dual drive adaptor is used in conjunction with flexible shaft drives where more than one unit is to be driven from the same power sources. It is also used to provide two ratios from the same source, or to aid in attaching flexible shaft drives where limitations in space prevent direct connection without bending



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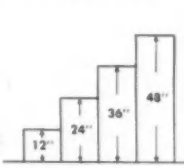

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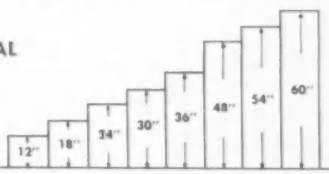

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- Thanks to the much smaller size of exclusive A-H "Right Angle" Design Starters, ratings can be increased up to and including 30 H.P. without increasing the size of the compartment or the Control Center. Simply replace the original starter with a larger unit; for example . . .

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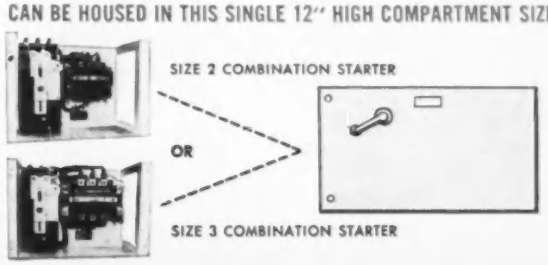

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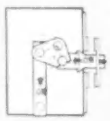
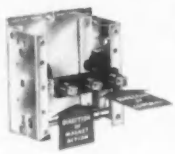
THE ARROW AH HART MOTOR CONTROL CENTER

Special Features

EXCLUSIVE ARROW-HART "RIGHT ANGLE" STARTER DESIGN



The remarkable space savings possible with Arrow-Hart Control Centers are, in turn, made possible largely through the much smaller size and lighter weight of A-H "Right Angle" Starter Units. Basic in this revolutionary design is a completely different type of operating mechanism. Working through a bell crank lever, a much smaller magnet is able to outperform the old fashioned, direct-acting type. This first real advance in motor control design in over 20 years is now thoroughly tested, approved and acclaimed throughout industry. Here are some of its important benefits —



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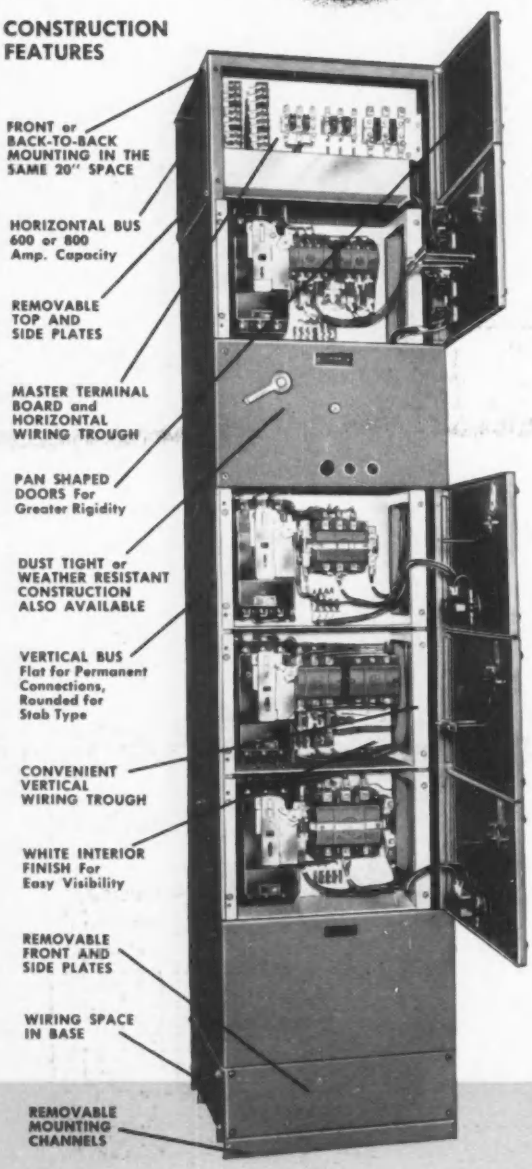
- **STRAIGHT-THRU FRONT WIRING**
- **ALL PARTS EASILY ACCESSIBLE FROM FRONT**
- **VERTICAL CONTACT POSITION PREVENTS ACCUMULATION OF BREAKDOWN MATERIAL**
- **IMPROVED PERFORMANCE and DEPENDABILITY**
- **POSITIVE UNDERVOLTAGE RELEASE**
- **POSITIVE CONTACT ALIGNMENT**
- **SUPERIOR ARC SUPPRESSION with completely isolated individual arcing chambers**

CONSTRUCTION FEATURES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REMOVABLE TOP AND SIDE PLATES
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WIRING SPACE IN BASE
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The newly re-designed external handle mechanism assures safe operation at all times. The door cannot be opened unless the handle is turned to "OPEN" with the circuit breaker or disconnect switch in the safe "OFF" position.

To assure safe maintenance, the handle can be locked only in the "OFF" position, and provision is made for 3 padlocks. The circuit breaker is equipped with a truly self-aligning mechanism that aligns the handle with the actual position of the breaker when the door is closed.

TWO TYPES OF STARTER CONNECTION TO THE VERTICAL BUS

THE PERMANENT TYPE . . . utilizes wires from the Starter Units bolted to the vertical bus. Mounting depth is the same for both front mounting only and for back-to-back mounting.

THE SELF-LOCKING "STAB" TYPE . . . utilizes Starter Units equipped with "Stabs" that "plug in" to the vertical bus. Starter Unit can be instantly and safely installed or removed while the bus is "hot" without shutting down the Control Center. Arrow-Hart Stabs provided with free-floating, self-aligning clips assure fast, positive, "no hunt" connections.

3 TYPES OF CONSTRUCTION

NEMA A, B or C

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- **SO MANY ADVANTAGES**
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the shaft to the point of possible damage.

It is furnished with standard $\frac{5}{8}$ in. x 18 threaded connections with 0.104 in. internal square drives, and in ratios of 1 to 1, 15 to 1, 16 to 1, and 17 to 1 for either left or right rotation.

The body is aluminum alloy with brass connectors, and the hardened steel gears run in oil-lite bearing which are permanently lubricated for high and low temperatures.

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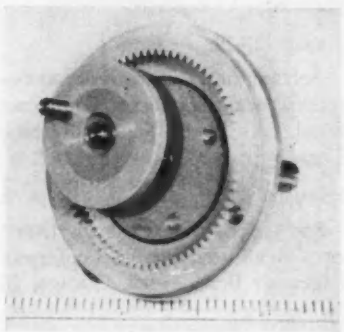

set indexing (3 position 90 deg apart) a low friction, high accuracy, and simplicity of design in a completely self-contained unit.

Mechanism weighs 2 oz, is accurate to 0.2 percent full scale. Tolerances: the unit zeroes through 2 holes within 0.001 in.; and stroke is 0.750 ±0.0015 in. each side of zero.

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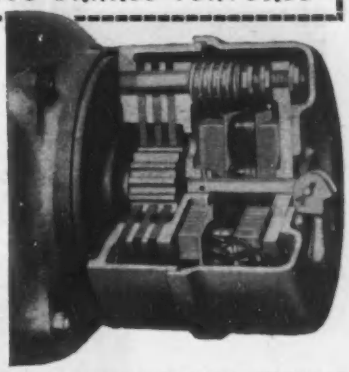

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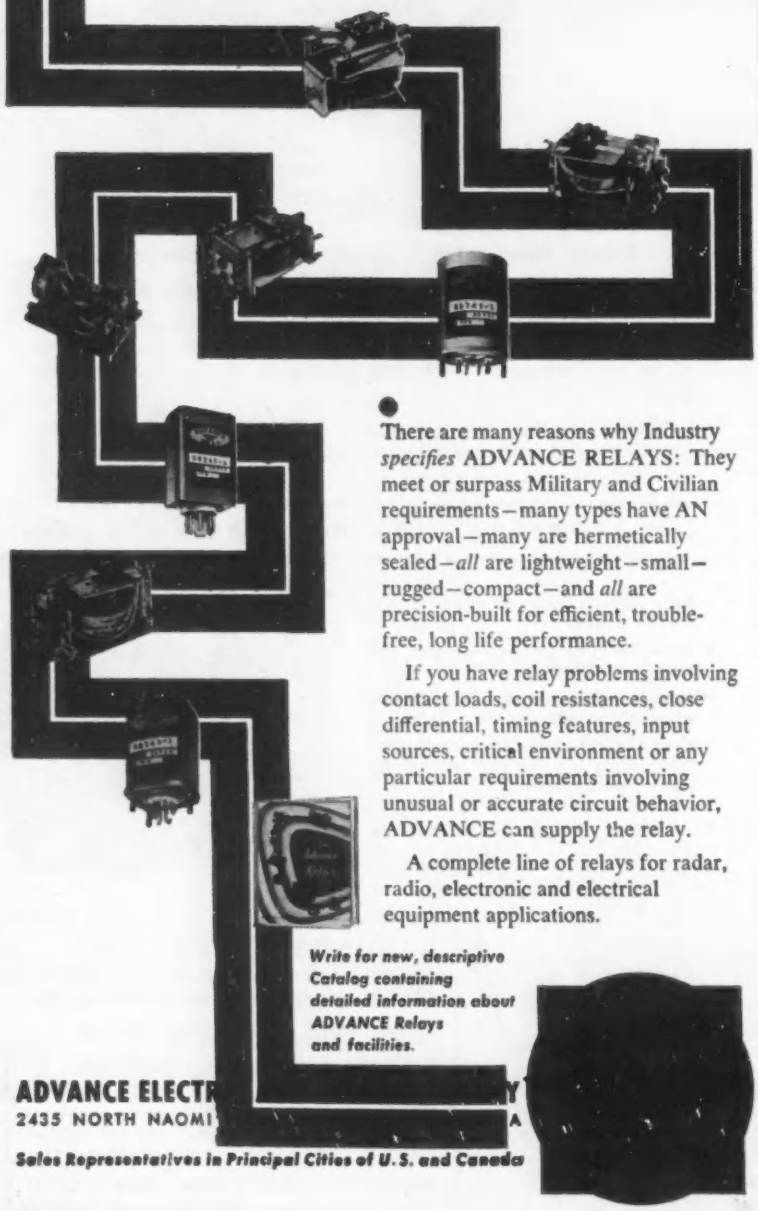

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December 8-10

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—AIEE, ACM, and IRE Eastern Computer Conference, Statler Hotel, Washington, D. C.

January 11-15

SOCIETY OF AUTOMOTIVE ENGINEERS—Annual Meeting and Display, Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Mich.

January 18-22

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Winter General Meeting, Statler Hotel, New York.

January 22

MALLEABLE FOUNDERS' SOCIETY—General Society Meeting, Hotel Cleveland, Cleveland, Ohio.

January 25-28

PLANT MAINTENANCE & ENGINEERING SHOW—International Amphitheatre, Chicago, Ill.

January 27-29

SOCIETY OF PLASTICS ENGINEERS—International Plastics Conference, Royal York Hotel, Toronto, Ontario, Canada.

February 3-5

SOCIETY OF THE PLASTICS INDUSTRY—Reinforced Plastics Conference, Edgewater Beach Hotel, Chicago, Ill.

February 4-6

INSTITUTE OF RADIO ENGINEERS—Southwestern Conference and Electronics Show, Hotel Tulsa, Tulsa, Okla.

March 2-4

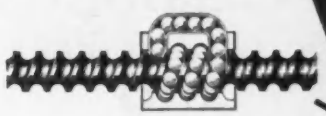
SOCIETY OF AUTOMOTIVE ENGINEERS—Passenger Car, Body and Materials Meeting, Hotel Statler, Detroit, Mich.

March 8-11

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION—Spring Meeting, Edgewater Beach Hotel, Chicago.

March 15-19

NATIONAL ASSOCIATION OF CORROSION ENGINEERS—Conference and Exhibition, Municipal Auditorium, Kansas City, Mo.



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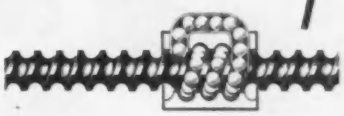

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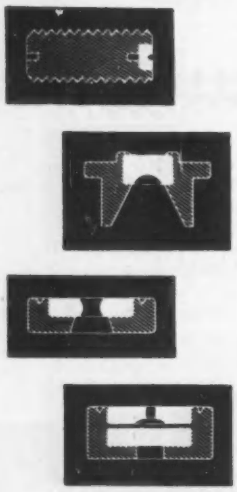

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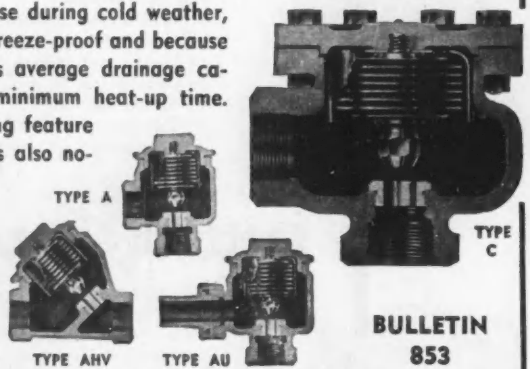

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Catalogs and Bulletins

Request additional information using postcards following page 224

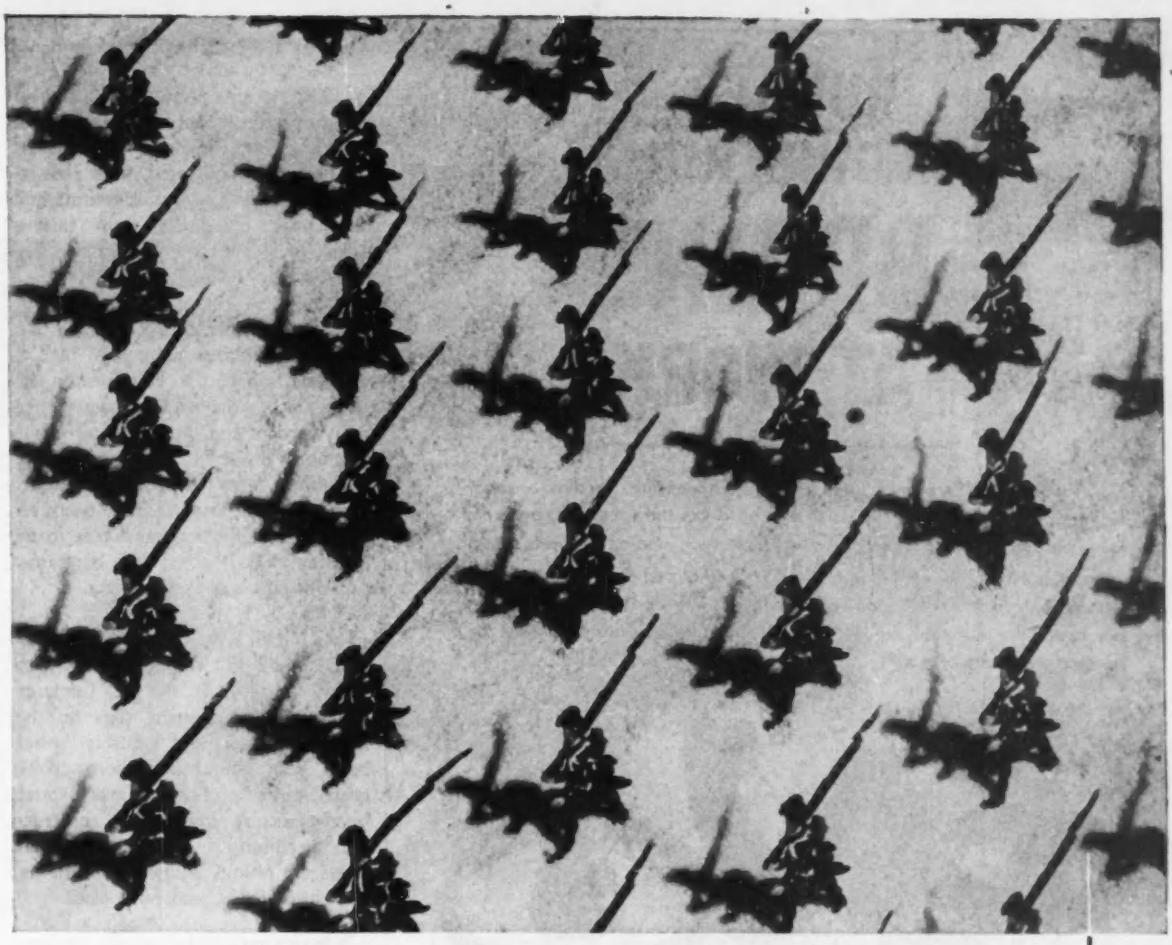
(1) BLOWER ASSEMBLIES — Viking Air Conditioning Corp. Booklet 564, 16 pp. Designed for use by manufacturers and designers of residential heating and cooling equipment, it gives step-by-step information necessary to select the proper belt driven assembly to fit the design and capacity of a heating or cooling unit. Has many tables, curves, illustrations, and other engineering data.

(2) MINIATURE PRECISION CONNECTORS — Gorn Electronics. Bulletin, 6 pp. Has complete engineering data on a line of precision connectors for 1 to 100 contacts, suitable for portable, airborne, rack to panel, and cable to panel applications. Male contacts, brass; female contacts, spring temper phosphor bronze. Has illustrations and diagrams.

(3) INDUSTRIAL V-SHEAVES — Durkee-Atwood Co. Bulletins D-170 and 172, 28 pp. All engineering specifications for light duty, type industrial V-sheaves with OD from 1.5 to 19.0 inches. Also data on single, two, and three groove, and variable pitch sheaves. Has similar data for QD double duty V-belt sheaves.

(4) ROTARY PRESSURE JOINTS —The Johnson Corp. Bulletin 853-5M, 8 pp. Has cutaway views and engineering drawings of a line of Type N rotary pressure joints that are packless and self-adjusting, and designed for use where an auxiliary inlet or outlet pipe must rotate with the cylinder. Also has data on the type S joint used where lateral movement is encountered. Both types for pressures to 250 lb, and type S.

(5) SILVER BRAZING PREFORMS — Lucas-Milhaupt Engineering Co.



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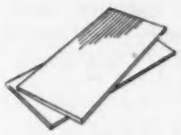

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(6) INDUSTRIAL INFERENTIAL METER—Simplex Valve & Meter Co. Bulletin 500, 16 pp. Has data on the operation, construction, accuracy, primary devices and other general information of interest to engineers dealing with fluid flow problems. A venturi type meter, it has accurate measurement over a wide range. Has many cutaway views, curves, flow diagrams, capacity table, and other data.

(7) RIGHT ANGLE GEAR SPEED REDUCERS—D. O. James Gear Mfg. Co. Catalog 42-B, 82 pp. Contains informative engineering data on the following gear speed reducers: spiral bevel gear; spiral bevel-herringbone gear; spiral bevel-helical gear; spiral bevel-planetary gear. Has construction specifications, examples, sectional views, hp ratings, allowable overhung and thrust loads, and other data.

(8) ELECTRIC HEATING UNITS —Watlow Electric Mfg. Co. Catalog. Has descriptive data, specifications, and illustrations on a line of strip, cylindrical, ring, cartridge, tubular and immersion heaters, package sealing devices, hot plates, thermostats, rheostats, switches, contactors, condensers, insulators, and leads. Also discusses: wattage requirements, heat losses; specific heat tables of various substances, and other points. Has many illustrations.

(9) METAL MOULDINGS—Pyramid Mouldings Inc. Booklet W5-25M, 20 pp. Completely illustrated with the many types available, it gives all necessary data for a line of snap-on mouldings; nosings, coves and edgings; card guides and trim rings; channels, angles, dividers, tees; special shapes; end closures; and supplementary operations.

(10) FASTENERS—Strong, Carlisle & Hammond Co. Booklet, 18 pp. With illustrations of the many products, it suggests how improved product design can realize savings in space,

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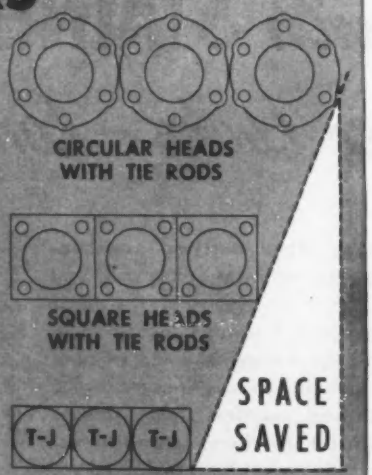

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(11) SPEED REDUCERS & GEARS —Grant Gear Works. Catalog 70, 178 pp. With illustrations of all types, it contains complete specifications for spur gears; bevels and miters; worms and worm gears; spirals and feed screws; internals and racks; a line of speed reducers; ratchets and pinion wire; sprockets and chains; cast tooth gears; couplings and universal joints; and engineering data and tables.

(12) NON-DESTRUCTIVE TESTING—Magnetic Analysis Corp. Bulletin 10, 8 pp. Illustrates and describes the multi-method equipment for non-destructive testing of ferromagnetic bars, wire rods, and tubing, at high rates of speed. Has illustrations of various types of flaws.

(13) SUPERCHARGERS — Miehle-Dexter Supercharger. Bulletin 153, 4 pp. Information on a line of superchargers for internal combustion engines, and blower and air compressor operations. Range of sizes for unsupercharged engines from 100 to 750 hp. Models from 15 to 4,000 cfm at pressures of 2 to 15 psi. Has illustrations, cutaway views, and graphs.

(14) PERFORATED METALS — Standard Stamping & Perforating Co. Bulletin, 4 pp. Has illustrations and dimensions of some of the various designs available in perforated metals, masonite, plastic, and coated stocks for use in screens, furniture, lighting fixtures, engine guards, radiator covers, sound proofing, decorating, vibrating screens, and many others.

(15) IRON POWDER PARTS—The National Radiator Co. Booklet, 28 pp. Has actual production facts about mechanical parts fabricated from electrolytic iron powder. Curves show elongation, tensile, yield, and impact strengths. Also has data on tolerances, finish, production rates, and tools.

(16) PHENOLIC MOLDING PLASTICS—Bakelite Co. Booklet M-1, 18

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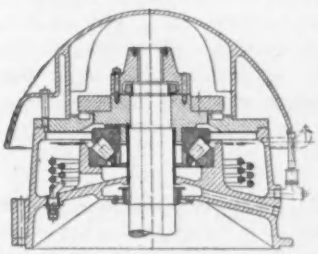

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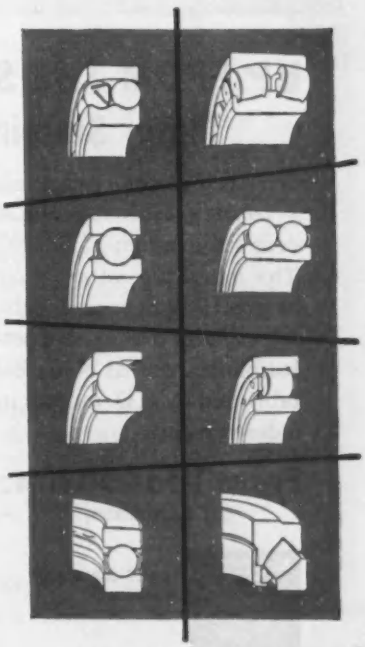

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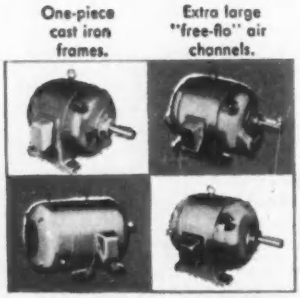
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(17) MACHINE TOOLS AND THEIR LUBRICATION—Shell Oil Co. Catalog, 80 pp. Not a shop manual, but rather a discussion of the fundamental factors found in the construction, operation and maintenance of modern machine tools. The four sections are: The history and development of machine tools; methods used in controlling power and directing force in a machine tool; types of motion and degrees of friction in machine tools; the role of the lubricant in machine tool operation. Discusses all types of machine tools, and hydraulic systems, and has large color drawings, cutaway views, and schematic diagrams.

(18) GLASS SEALS—Stupakoff Ceramic & Mfg. Co. Bulletin 453, 36 pp. Data on alloy-glass terminals for hermetic sealing. Not mechanical compression seals, but bonded by the chemical interaction of the oxide of Kovar fused with boro-silicate glass. Has information, illustrations, and specifications for a variety of terminals.

(19) KEY SWITCHES—Automatic Electric Co. Catalog 4018-D, 30 pp. Contains specifications and general data on key switches, impulsing devices, switchboard lamps, jacks and caps, and other control devices. Also data on limit switches, target indicators, rectifiers and fuses, and adjusting tools. Has illustrations of each unit.

(20) BALL BEARINGS — Ahlberg Bearing Co. Catalog 442, 18 pp. Complete specifications for a line of ball bearings, including single row; angular contact; front wheel; double row; self aligning, inch bore; and thrust bearings. Has illustrations of each type, plus a variety of informative tables.

(21) PACKAGE PLUG-IN CIRCUITS—The Electronic Engineering Co. of California. Booklet, 12 pp.

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Smallest Ball Bearing Ever Manufactured Commercially

An RMB *First*

These bearings, developed by RMB, are not toys. Type C1, and the other ten sizes in the C series, are hard-working components of—

- Delicate Instruments
- Small Motors
- Scales and Gauges
- Small gear trains for clockwork
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—anywhere a miniature bearing is needed to reduce friction, where space is at a premium. Bring your miniature bearing problems to RMB. A complete line of over 250 miniature and instrument bearings including radial and roller types available for prompt delivery. Experimental quantities from stock.

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RMB LANDIS & GYR, INCORPORATED

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Catalogs and Bulletins.....continued

Describes a line of package plug-in circuits which may be taken apart, tells how they were designed, advantages, applications, and specifications for 20 versions. Also lists 26 other types available on special order.

(22) AIR & HYDRAULIC CONTROL VALVES—C. B. Hunt & Son, Inc. Bulletin 531, 12 pp. Has complete data on a line of sliding sleeve air valves for air pressures up to 125 psi; single plunger valves for air, water, hydraulic oils at pressures up to 300 psi; O and OE type valves for air, water, and oils up to 125 psi; and hydraulic valves for pressures up to 5,000 psi. Has many types of operations including push button, diaphragm, pilot cylinder, solenoid and cam.

(23) FLEXIBLE SHAFTING—Stow Mfg. Co. Bulletin 525, 12 pp. Has engineering data on the flexible shafting for power drive and remote control applications. For power drive, the shafts transmit a max of 1,500 in.-lb. For remote control, a max of 4,000 in.-pounds.

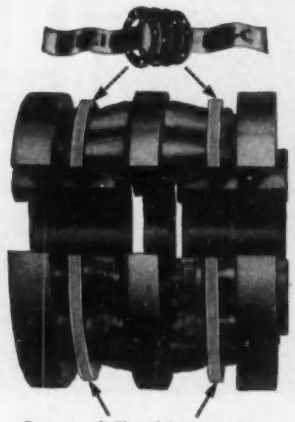
(24) FLOAT AND LEVER VALVES—Schade Valve Mfg. Co. Catalog 107, 16 pp. Has many illustrations and complete specifications for a line of float and lever valves for water, air, gas, and oil. Max inlet pressure for some styles is 400 psi, and lower for others. Available in sizes from ¼ in. to 12 inches.

(25) HYDRAULIC-MAGNETIC OVERLOAD RELAY — Heinemann Electric Co. Bulletin 5101 A, 4 pp. Has complete engineering data, model specifications and information on the application of the Silic-O-Netic overload relay. Includes a description of the hydraulic-magnetic operating principle, and shows the principle in graphic form, along with data on the hermetically sealed time element. Has full engineering data and specifications for all models.

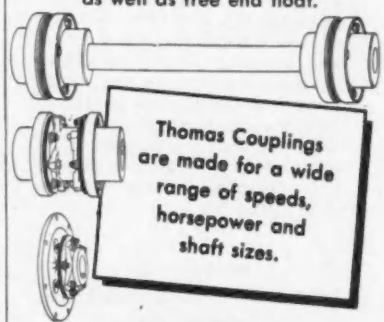
(26) DIAL THERMOMETERS — The Foxboro Co. Bulletin 467, 16 pp. Describes a line of dial thermometers for long distance measurement. Has complete data on temperature indicators of the vapor pressure and gas pressure types. Ranges are from —300 to 600 F in Class II, and from —250

Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs

DISTINCTIVE ADVANTAGES	
FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.



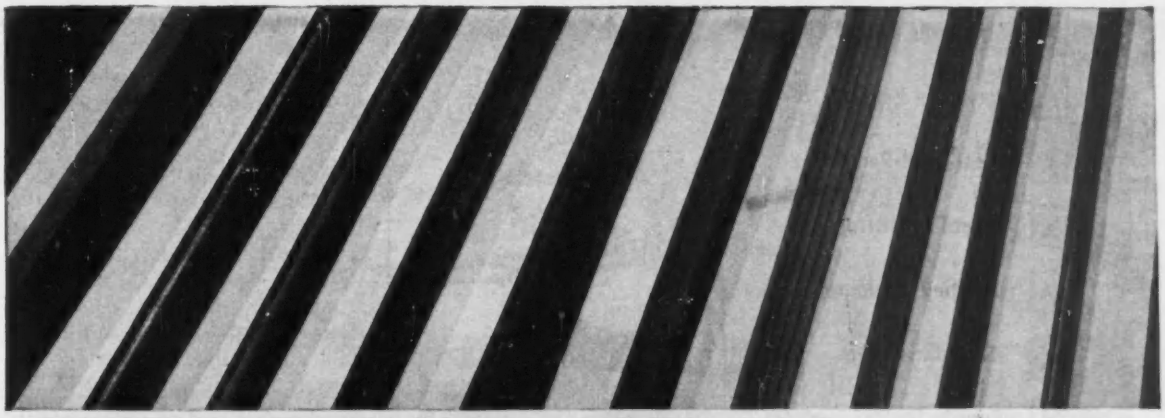
THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

NO MAINTENANCE PROBLEMS

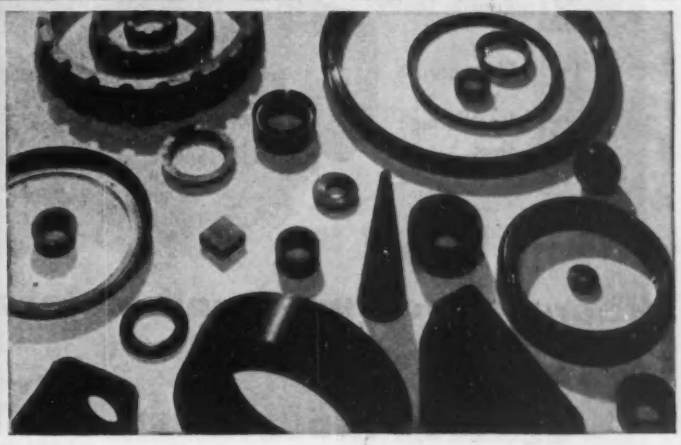
ALL PARTS ARE SOLIDLY BOLTED TOGETHER

Write for our new Engineering Catalog No. 51

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.



Unsurpassed *Synthetic* RUBBER COMPONENT PARTS



Users of Acadia Synthetic Rubber component parts in hundreds of industries have found them unsurpassed. No matter what function synthetic rubber must perform, depend on Acadia parts. They best meet exacting specifications and operating conditions such as moisture, oil, heat, wear and age resistance. Molded, extruded, die-cut to close limits—compounded to meet specific conditions. Acadia engineers will gladly cooperate.

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- *Washers*
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- *"O" Rings*
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- [X] Dictating Machines
- [X] Room Circulators
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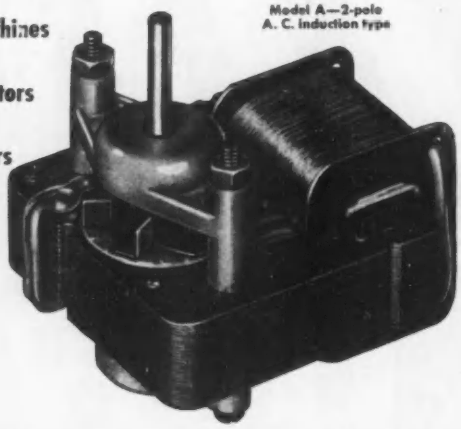
- [X] Phonographs
- [X] Ventilating Fans



Model A—2-pole A. C. induction type

Wherever you use small motors . . . specify GENERAL INDUSTRIES' *Smooth Power* Motors

1/65-1/500 H.P.

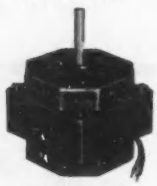
Designed to provide years of dependable service on small-load applications, General Industries' *Smooth Power* Motors are engineered and built to provide full-rated power, smoothly and dependably.

Many thousands of these compact power units are in use today in a wide variety of applications requiring steady power and long life, at low original cost, low operating cost and low maintenance cost.

Write for literature showing output, dimensions and other characteristics of these dependable small motors.

Model C—2-pole A. C. induction type

Model O—2-pole reversible capacitor type (for 6 or 12 or 24 volt A. C. only)



Model D—4-pole A. C. induction type

50th ANNIVERSARY 1903-1953

THE GENERAL INDUSTRIES CO.

DEPARTMENT MM • ELYRIA, OHIO

Catalogs and Bulletins.....continued

to 1,000 in Class III. Has section devoted to accessories, and diagrams show suggested installation methods.

(27) CORROSION RESISTANT FITTINGS—Horace T. Potts Co. Booklet S7-5314.5M, 24 pp. Data on corrosion-resistant fittings for use with light-wall pipe, plus illustrations of fittings with size ranges, dimensions, tolerances, test data, accessory equipment, charts, tables, and methods and general information on soldering, welding, and brazing stainless steel. Features the new tangential fitting in piping layout. Has many illustrations and curves.

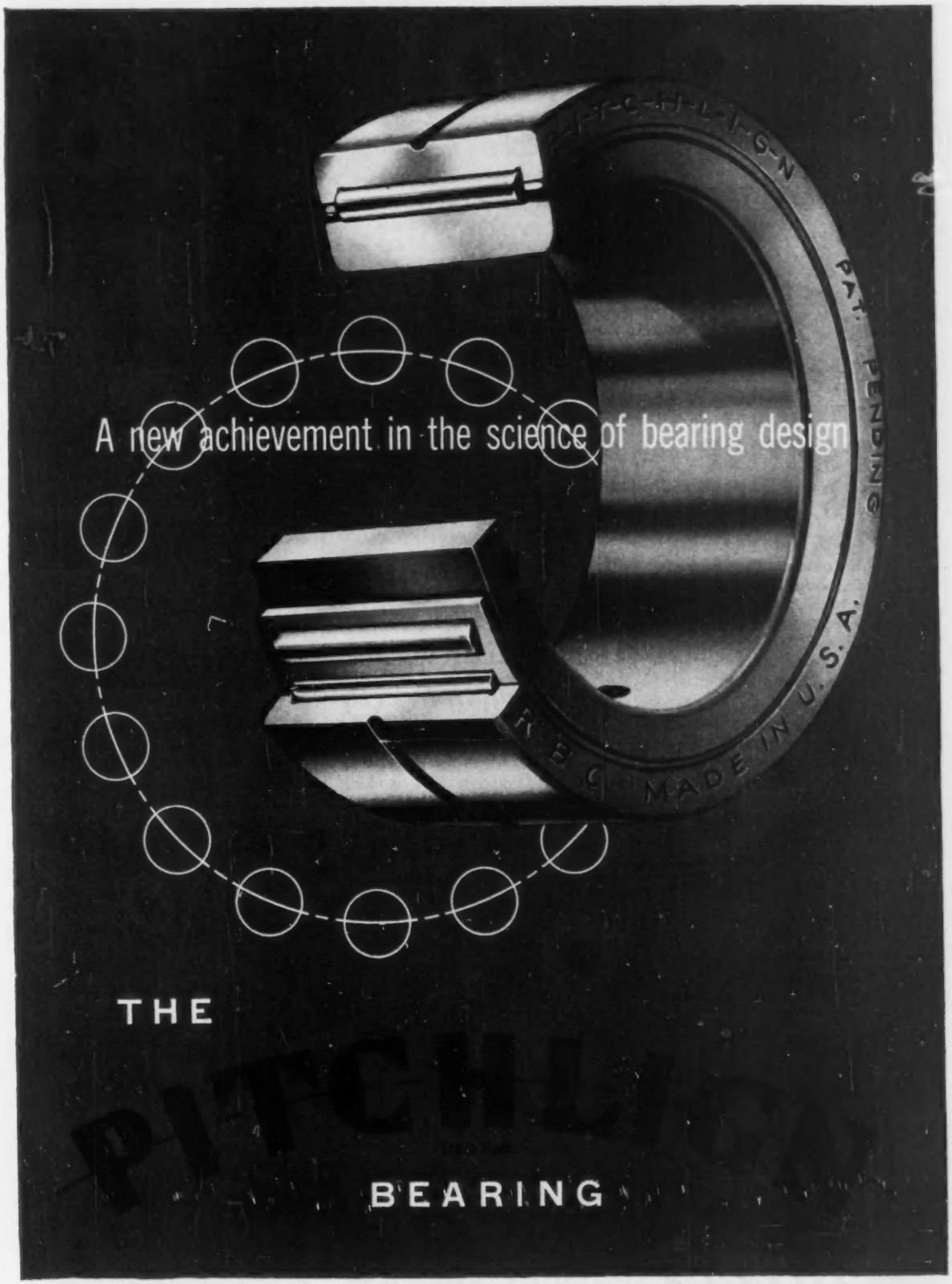
(28) V-BELT DRIVES — Boston Woven Hose & Rubber Co. Manual, 52 pp. Covers such subjects as how to select a V-belt drive, how to select a V-flat drive, V-belt drive design sheet, non-standard drive instructions, speed-up drives, and tables on each subject. Also has graphs and diagrams.

(29) MAGNETIC FLUID CLUTCH —Texas Instruments Inc. Bulletin DL-C311, 2 pp. Describes an instrument size magnetic fluid clutch metering/positioning movement, along with detailed performance specifications, and curves. Describes both the movement and the component magnetic fluid clutches.

(30) HYDRAULIC POWER PUMPS—Adel Div. Booklet 155-67, 4 pp. Gives general specifications, pump performance characteristics, operating characteristics, and pump capacity selection chart. In eleven models the gpm output ranges from 1.62 to 49.5, and the hp input from 0.30 to 34.0 at pressures from 200 to 1,000 psi.

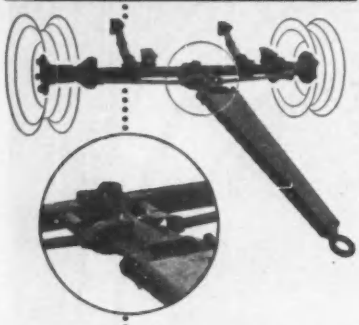
(31) ELECTROPLATED GOLD — Technic Inc. Booklet, 4 pp. Contains physical, electrical, thermal and chemical properties of this material. Also has curves on optical properties, and the effect of gold concentration on current efficiency. Other data cover electroplating specifications; diffusion coefficients; applications; and nickel gold.

(32) SHELL MOLDING—Builders Iron Foundry Inc. Bulletin 100-K12, 4 pp. Describes the foundry technique of the production of castings by



Write for Bulletin SF-669 Roller Bearing Company of America, Sullivan Way, West Trenton, New Jersey

CARAVAN AXLES



feature
AUTOMOTIVE STEERING

Only CARAVAN axles with automotive steering assure dependable roadability on both highway and rough ground. For positive trail at high speeds, these job-engineered assemblies feature controlled camber, tow-in and caster.

Stability for the heaviest loads is provided by massive center steering arm, extra-heavy center arm stop blocks and heavy duty steering knuckle. Wide inside wheel turning angle assures maximum maneuverability and eliminates jack-knifing.

CARAVAN units are available in a variety of types and sizes in both 2 and 4-wheel assemblies for portable equipment weighing from 500 to 14,000 lbs. They are recommended for use with military and industrial as well as field service and construction equipment. 1128-UM

Write today for the new Bulletin No. 53 for further information.

UNITED MFG. COMPANY

1221 W. INTERSTATE ST. • BEDFORD, OHIO

Catalogs and Bulletins.....continued

the shell mold process, and illustrations showing how a typical shell mold casting is made. Also has illustrations of other castings and lists comparative cost data.

(33) HYDRAULIC EQUIPMENT—Donnell Hydraulic Co. Booklet 102-10M, 10 pp. Has illustration, performance curves, and other data on a 6 and 12 v electric hydraulic self-contained pump used on trucks, tractors, and other equipment. Also has illustrations and specifications on a line of hand pumps; rams and power valves.

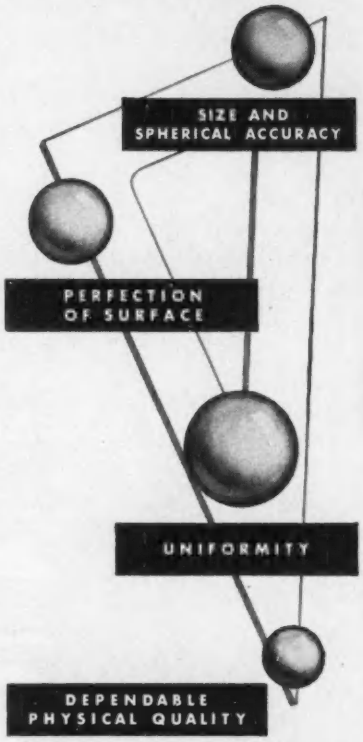
(34) COMPLEX PLANE ANALYZER — Technology Instrument Corp. Bulletin, 6 pp. Complete information on the type 250-A complex plane analyzer, a computor for Network Analysis and control system design. A detailed description of the instruments theory and operation is included along with lists of specifications and features. Has illustrative examples of different problems.

(35) TANTALUM CAPACITORS —Fansteel Metallurgical Corp. Bulletin 6.100-1, 4 pp. Describes a new series of tantalum capacitors of the porous tantalum electrode type. Lists and illustrates 3 sizes of capacitors in a variety of capacity and working voltage ratings from 325 mfd at 6 v d-c to 25 mfd at 125 v d-c. Curves show temperature characteristics.

(36) ATMOSPHERIC CORROSION OF LOW ALLOY STEELS—The International Nickel Co. Inc. Bulletin A-149, 22 pp. Well documented with charts and tables, it reports the effects of 9 years atmospheric exposure on low alloy steels. Has data on weight losses, pit depths, thickness measurements, and weight of rust on specimens. Effects of composition are discussed. Has many curves.

(37) ALUMINUM ALLOY STRIP —Scovill Mfg. Co. Booklet, 20 pp. Discusses annealed tempers of wrought aluminum strip alloys; methods of determining directional properties of wrought aluminum alloy strip; characteristics of wrought aluminum alloys; fabricating characteristics; and standard temper designations. Has charts and diagrams that are complete with all properties of various alloys.

from any angle



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If you have a metal ball problem, why not let Strom solve it for you. Whether for precision ball bearings or for one of many other ball applications . . . Strom will supply the *right* ball to meet your requirements. For more than a quarter century, industry has looked to Strom for metal balls of unsurpassed quality.

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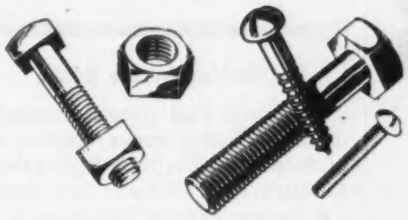

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You know how essential the right fasteners are to your product. They must be dependable, economical, properly designed and rigidly manufactured to measure up to your own product standards.

In many cases, you can meet every requirement by ordering standard fasteners from the most complete line made for industry, by National.

And, when you need a special fastener . . . there's no problem either when you call on National. For more than 60 years, our reputation has grown and our facilities have expanded . . . because we have been able to answer industry's need for an endless variety of specially engineered headed and threaded products.

With some 3500 producing units, from cold-heading equipment to many types for secondary operation, we offer you experience and facilities second to none. We can tell you how your part can be produced economically and speedily . . . in the volume you need . . . and to the National standards of quality.

For the right fastener, essential to your product, send us your specifications or call your nearest National representative.

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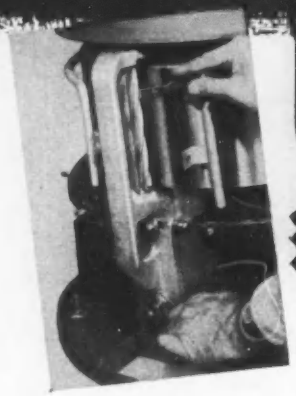
National PRODUCTS

FASTENERS HODELL CHAINS CHESTER HOISTS

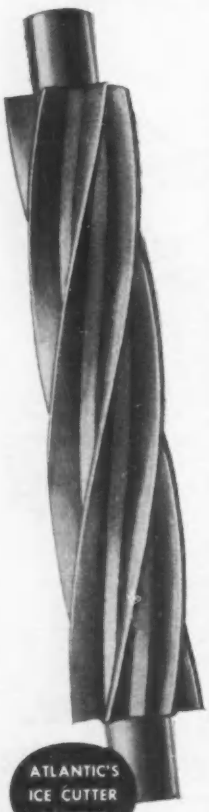
COLD FACTS

about YORK'S new ICE CUTTER



YORK FLAK-ICE AUTOMATIC ICE MAKER, MODEL DER-2

ICE HARVESTING SYSTEM



ATLANTIC'S ICE CUTTER CASTING

AN IMPORTANT COMPONENT of York Corporation's most recent development, the York-Flakice Automatic Ice Maker, is Atlantic's ice cutter casting. It cuts the ice into curved flakes... so delicate they will not damage or puncture delicate rose petals.

YORK'S ORIGINAL CONCEPTION of the ice cutter... a vital part of the ice harvesting system ...consisted of three stainless steel parts which had not only to be machined, but welded together.

ATLANTIC'S ENGINEERS suggested a design that eliminated these costly operations and increased the productive efficiency of the ice cutter. Six spiral blades on a center shaft were all plaster mold cast in one piece of Atlantalloy #31 High Tensile Manganese Bronze... an alloy of great endurance and strength.

York will testify that Atlantic's all-in-one-piece ice cutter casting surpassed all requirements for high physical values, closely-held tolerances, satin-smooth finish, fine-grained structure, clean-cut surfaces... and afforded them substantial savings over former costs.

Find out how the Atlantalloy plaster mold casting process can help solve some of your problems. Write for a free copy of "High Quality Precision Castings for Industry" today!

ATLANTIC CASTING and ENGINEERING CORP.

Established 1937

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Sans, Souci

Ad Libbing by the Editor

My friend Paul Arnold, manager of the marketing service department of the Reliance Electric & Engineering Company, wrote me a nice letter about our October editorial, "Picturing the Brain Child." Obviously, Mr. Arnold got the whole idea behind the editorial and his fertile mind expanded upon it. He put an additional twist to it, namely, the idea that if a man does not know his product he cannot be expected to be able to sell it. That additional twist brings to mind the old time school of selling.

In the early days of my career I often heard the expression, "A good salesman can sell anything and doesn't need to know anything about the product." Admittedly, if we go back far enough into the early days of civilization, a good salesman could sell anything, because there wasn't much to know about anything. There is the story of the fellow who sold wooden nutmegs. He didn't have to know anything about nutmegs to sell wooden ones. And then there is a story of Sam Slick who sold the same book over and over again and never delivered a copy.

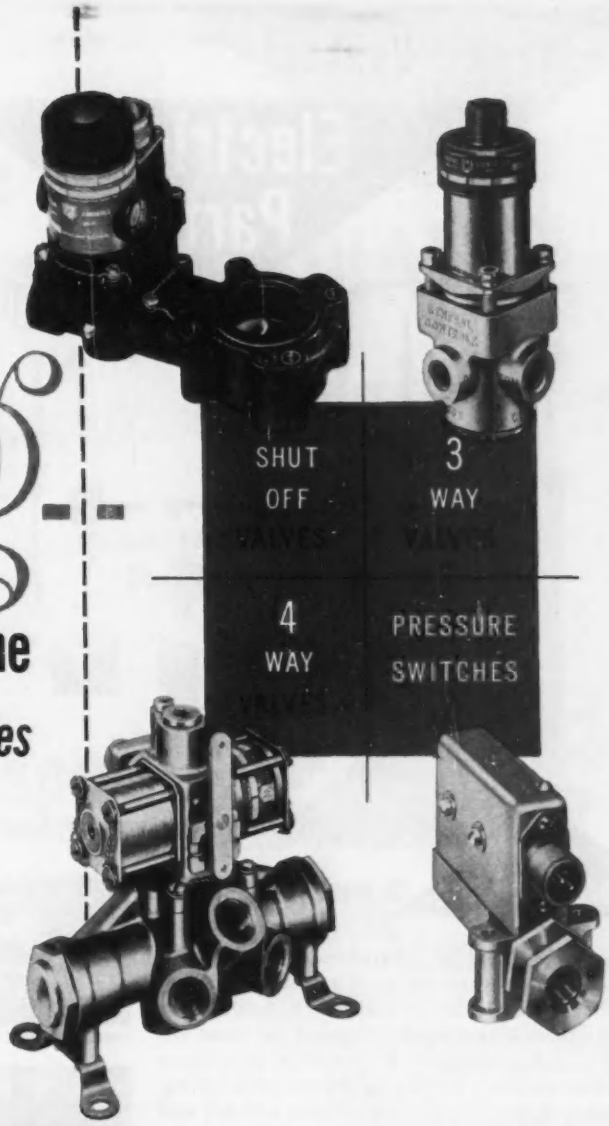
In the industrial field, the illustrious Diamond Jim Brady sold all kinds of railroad equipment and I dare say he knew practically nothing about the goods that he was selling. In fact, his technique was to make his prospects feel under personal obligations to him by the simple method of treating them lavishly. One might almost call it bribery. And at the psychological moment Diamond Jim held out the order blank to sign and the deal was closed.

In one of my early jobs we had an Irish salesman called Mac. He was the most likeable fellow you would ever want to meet. His knowledge of the products he was selling wouldn't have put him above the kindergarten grade. I wrote an editorial some years ago about his trying to sell flood lamps, the feature of which was a glass reflector. Poor Mac was terribly put out when the prospects insisted that he disassemble the lamp and take out the reflector so that the prospects could look it over at close range. Mac did, but the prospect decided that he didn't

hi-g

for any machine

that rolls, floats, or flies



hi-g

In engineering terms "high g" means high gravitation forces. In performance terms "Hi-g" means General Controls' reliable line of automatic pressure, temperature, level and flow controls for heavy duty under acceleration factors from 10 to 300G. The Hi-g line comprises electromagnetic pilot and shutoff valves . . . manual and motor-driven gate valves . . . electrohydraulic selector valves . . . gauge and differential type limit controls . . . all light in weight, compact in design and trustworthy in operation . . . handling a great variety of liquids and gases in a wide temperature range.

For high efficiency performance under extreme vibration and acceleration conditions it's General Controls Hi-g Controls . . . the best in automatic control for any machine that rolls, floats or flies.

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Manufacturers of Automatic Pressure, Temperature, Level and Flow Controls for Heating, Home Appliances, Refrigeration, Industrial and Aircraft Applications.

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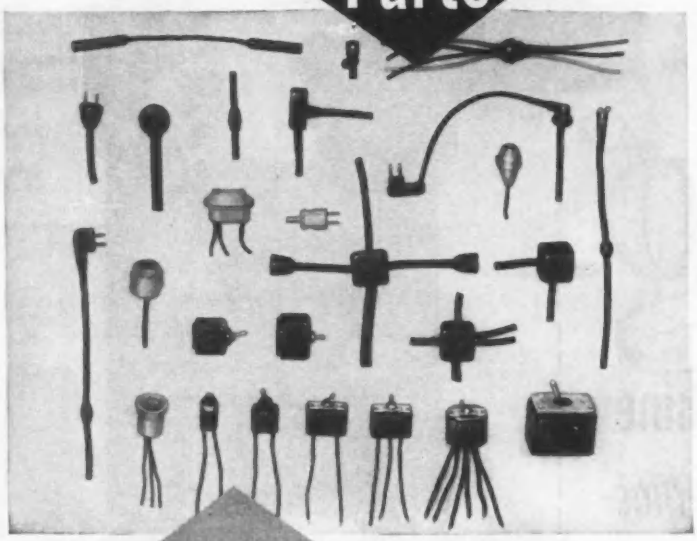
Molded Rubber Electrical Parts



Designed by Experts to solve your problems...

Produced on time to meet your schedule!

What's *your* problem? If it involves molded rubber electrical components for your product, look no further! Because the design and production of such parts is a Riverside specialty . . . and has been for years! Yes, from appliances to ordnance, prominent manufacturers bring us their problems concerning: • Waterproofing • Electrical insulation • Shock and vibration • Resistance to salt spray, sunlight, oxidation, wear, abrasion, etc. • Extremes in temperature . . . and many other challenging problems.

As a result, we have built up a considerable bank of valuable experience in the engineering and production of molded rubber parts. The answer to *your* problem can probably be found in this file of successful "case histories" . . . and if not, our well-qualified Engineering Department will *give* you the answer *fast!* Send parts, prints, or details of your problem for prompt engineering recommendations and a firm quotation. No obligation to you, of course.

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want the lamp because the glass reflector would most likely break. Poor Mac felt bad over losing the order.

As a mechanic, Mac was about as awkward as they come and accidentally he pushed the glass reflector off the desk on which he was trying to reassemble the lamp. The reflector hit the linoleum floor with a bang, bounced a couple of times and rolled to rest. I guess nobody was more amazed than Mac. But Mac was a good salesman. He quickly got his wits together and said, "There you are, gentlemen, how can you deny yourself all of the virtues and benefits of this wonderful glass reflector when you have seen with your own eyes its tremendous resistance to breakage?" Mac got the order.

However, during the past decades the advancements in all fields of commerce and industry have been such that it is now essential in almost every field that the salesman know his product. The products of industry are not only much more complicated but the prospects are smarter buyers. They want explanations and proofs.

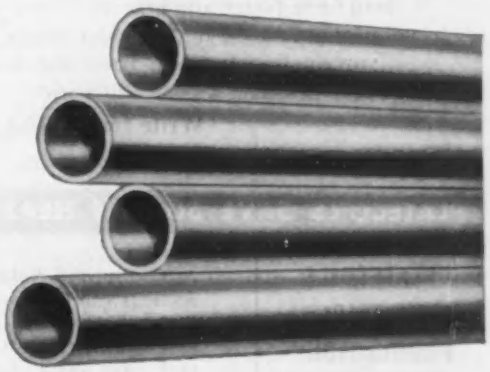
It is written of one of the great philosophers of the 19th Century that he was extremely critical of people who possessed what he would like to possess and that he also hated those accomplishments that he was unable to duplicate because of physical or mental limitations. On the face of it that sounds unusual but in fact it is a most common occurrence. The man who sneers at mathematical ability possessed by others is simply giving vent to his envy. The poor man despises wealth until he himself is rich. The man without musical talents hates musicians.

In view of this it is wise to take careful stock of one's own feelings towards others and their accomplishments. If we possesss the intelligence and the strength of character to overcome our emotions we might be able to sanely analyze the things we hate or despise. And almost invariably the sane analysis will reveal great merit in the object or thing that we hate and despise. Thereby we are able to broaden our viewpoints and profit immeasurably from an appreciation of finer things and an understanding of wherein we must strive in order to reach the higher levels. Then perhaps we too might be able to possess the things and abilities that we envy in others. Admiration achieves; hate destroys. —G.F.N.

You're sure of UNIFORM HIGH QUALITY

SEAMLESS • PRESSURE • MECHANICAL CARBON STEEL TUBES

when you specify GLOBE



SIZE RANGE — WALL THICKNESS

Globe seamless carbon steel tubes are available in a size range of ½ inch to 7½ inches O.D.; wall thickness of .028 to 1.000 inch.

APPLICATIONS

Globe Pressure Tubes are used for boilers, condensers, heat exchangers and process equipment. They meet most exacting demands of modern high pressure and high temperature installations. Globe Mechanical Tubing (seamless) is produced by piercing solid billets. It is an ideal material for low-bearing structural members and parts where strength with minimum weight is needed. Its economy for the manufacturing of many machine parts is universally recognized.

Globe seamless carbon steel tubes are furnished to standard specifications in low and medium carbon ranges.

WHEN you specify Globe you are sure of uniform high quality carbon steel tubes. That's because they are the product of highly developed production facilities and specialized quality controls and methods.

Globe engineers are at your service to assist in the selection of tubing of the exact characteristics you require.

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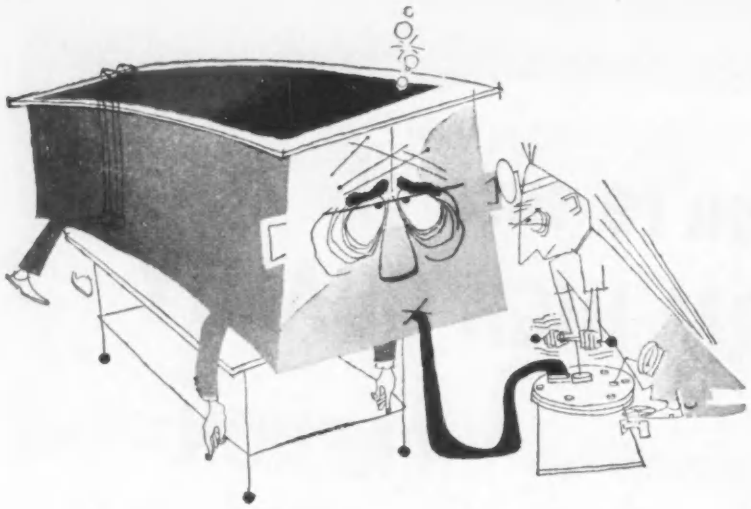
Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — alloy-carbon seamless steel tubes — Globeiron (high purity ingot-iron) seamless tubes — Globe welding fittings.



has **coil-itis*** cramped your production flow?

It's a waste of costly time to pump out the solution every time your process heating and cooling tanks get indigestion due to pipe coil troubles. You can save this cost and eliminate production bottlenecks by replacing the pipe coils with Platecoils. Platecoils can be removed and replaced **without dumping the solution**. They simplify maintenance and save hours of downtime. They heat or cool 50% faster and take 50% less space in the tank. As revolutionary as the new wonder drugs, Platecoils cure production troubles involving heat transfer . . . and give profits a shot in the arm.

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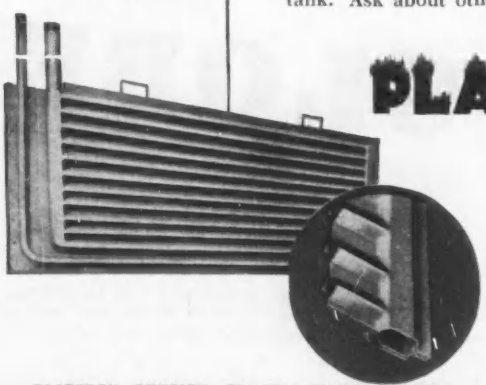
PLATECOILS SAVE 50% IN HEAT TRANSFER COSTS

PLATECOILS TRIPLE PRODUCTION

At Continental Motors Corp., 3 crankcase sections can be cleaned at one time when Platecoils are used while only one crank case can be cleaned with pipecoils in the tank. Ask about other case histories.



PLATECOIL

REPLACES PIPE COILS

*Coil-itis — Diagnosed as tank heating and cooling problems. Platecoils — the prescription for solving pipe coil problems.

PLATECOIL DIVISION, TRANTER MANUFACTURING, inc., LANSING 4, MICHIGAN

Powerful Transistor

A THIMBLE-SIZE TRANSISTOR, 100 times as powerful as present commercially available types, has been developed in the research laboratories of Minneapolis-Honeywell Regulator Company. Dr. Finn J. Larsen, research director, said the new power unit, which has an output of 20 watts, would do work not possible with the low-output types now being produced commercially, and thus should greatly expand the range of transistor uses.

As an example, he said it would likely play a major role in improving automatic controls of the future. Honeywell is one of the nation's largest manufacturers of such devices.

A prototype aircraft electronic fuel gage making use of the new transistor already has been built by the company, though it is not yet in commercial production.

The new transistor's power output contrasts with that of 20 hundredths of a watt for present commercial types of the electronic midgets that are replacing vacuum tubes in some applications. This greater power extends the application of transistors, to the control of equipment as motors, valves, relays and other equipment.

The key to Honeywell's development of a power-type unit was the discovery of an effective means of removing heat from the germanium-alloy junction.

Industrial Hydraulics Conference

NEED FOR "KNOW-HOW" was the dominant theme expressed at the National Conference on Industrial Hydraulics (NCIH) meeting in Chicago during October. Visitors to technical meetings heard that all phases of engineering—research, development, design and maintenance—need education in hydraulics. Most particularly, engineering students who will be entering the field require additional formal training in the subject.

A recent survey of engineering schools showed that only a handful had specific courses in oil hydraulics beyond the classical studies in standard hydraulics and fluid mechanics. Michigan State, Massachusetts Institute of Technology and University of Mich-

Chiksan Swivel Joints SAVE TIME AND MONEY
IN JOHNSON MOTORS DIE CASTING DEPARTMENT
Fluid losses cut 75%!
Setting up time reduced 75%!

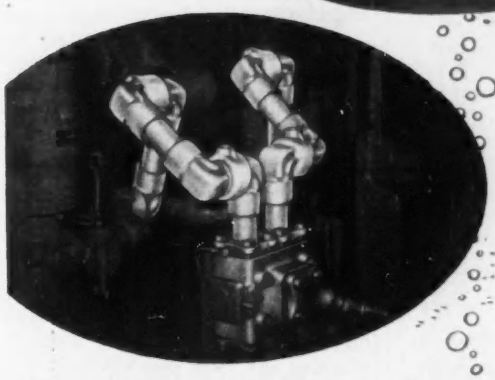
Safety of its people and property, plus increased efficiency and economy of operation, were the chief considerations which turned Johnson Motors to Chiksan Swivel Joints.

Johnson Motors die-casting department, one of the largest in the Middle West — and the largest captive plant in this country — selected Chiksan hydraulic swivel joints when it converted its machines from flammable oils to nonflammable hydraulic fluids.

Forty-eight package die casting machines are operated on a staggered three shift basis, producing more than 400 aluminum alloy die castings ranging from ½ ounce to 11 pounds in size. Hydraulic systems are operated at pressures up to 2000 psi, with average total die forces in the range of 300 to 500 tons. Castings are made at temperatures between 1100° and 1200° F.

Chiksan ball-bearing swivel joints have helped to reduce fluid losses from 40,000 gallons per year to 10,000 gallons. In contrast to former loss of from 1 to 3 gallons in repositioning bolted lines, Chiksan joints permit resetting of table level with virtually no fluid loss. Time consumed in resetting table levels has been reduced from 2 men and 1 hour to one man and 15 minutes of time.

This story is typical of the many ways thousands of manufacturers are using Chiksan ball-bearing swivel joints for greater safety, efficiency, and economy in their operations.



Chiksan ball-bearing swivel joints installed on Lester-Phoenix die-casting machine helped Johnson Motors meet its fluid cost problems.

For Safety, Economy and Efficiency in your die casting department Chiksan has plans and applications worthy of your immediate and serious consideration.

Write CHIKSAN Engineering Research Division today for our NEW Catalog No. 53-C, Dept. PE-12.

The Flow of Enterprise Relies on **CHIKSAN**

CHIKSAN TRADE MARK REG.

Representatives in Principal Cities

Ball-Bearing Swivel Joints

Los Angeles 22, California • Chicago 38, Illinois • Newark 2, New Jersey
Houston 1, Texas • Chiksan Export Company (Subsidiary), San Francisco 4, U.S.A.

In addition to supplying wire cloth in bulk, a fast-growing division of our company specializes in the fabrication or assembly of parts made from wire cloth. Many companies who formerly fabricated their own mesh parts now avail themselves of this service. After all, we know wire cloth—we've been making it for more than 75 years. We have the facilities, the skilled help, and the experience necessary to turn out these parts accurately and in small lots or in production quantities to meet your production schedules.

Some of our recent jobs are illustrated above. Perhaps one or more of these comes close to something you're working on right now. Write us giving complete details and specifications. If desired our experienced engineers will work with yours in the design of the part so as to make the most effective and economical use of the wire cloth. We shall be happy to quote on your requirements.

NEWARK for ACCURACY

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

igan are among the few that have such programs.

NCIH says this isn't enough, so they are starting a program of their own. They're working with the faculty of the Illinois Institute of Technology and setting up at IIT a training program with heavy emphasis on laboratory phases. The object: to train people in oil hydraulics from the maintenance level to the graduate level.

First formal training is underway at IIT now—a non-credit course in the evening school: "Introduction to Oil Hydraulic Power." It consists of three periods each night: (1) a lecture on fundamentals by NCIH's director, O. E. Teichman; (2) a lecture by a specialist from industry; and (3) a laboratory demonstration followed by a period for computing data and discussion.

Plans for next semester include a three hour course for credit at the senior college level, dealing with design factors in oil hydraulic equipment. Next summer one or more two-week intensive short courses at the maintenance level are to be offered. This work will be followed by graduate work as a research program is developed to aid in sponsoring and training graduate students.

Plastic Pipeline

FIRST-CROSS-COUNTRY PIPELINE made entirely of plastic has been completed in the Willston Oil Basin. Extending nine miles, the butyrate pipe is delivering crude oil from a storage tank to a tank car siding. The line is 3 in. ID with a wall thickness of 0.125 in. and was designed to operate at a maximum pressure of 90 psi and a temperature of 60 F.

There were two main reasons for installing the plastic pipeline instead of a steel one. Steel pipe carrying this type of oil corrodes badly and clogs with paraffin. Plastic, on the other hand, is relatively corrosion resistant, and preliminary tests have indicated no paraffin accumulation.

In addition, because of the light weight, installation of the pipeline was a comparatively easy job, completed quickly, with a minimum amount of manpower. Typical cost-saving property: 20 ft section of plastic pipe weighs 13 lb, compared to the 153 lb of a steel section of similar diameter and length.

ENGINEERING ABSTRACTS

Changes In Measurement Units

Abstracted from "Fundamental Units and Standards" by Francis B. Silsbee, National Bureau of Standards, *Instruments*, October, 1953.

POSITIVE STEPS are now being taken to overcome a situation in the field of fundamental measurement whereby the precision with which a unit can be maintained and with which standards embodying it may be compared is greater than the original accuracy and subsequent verification of the unit. *Length.* Measurement of the fundamental unit of length, the distance between two lines engraved near the ends of a platinum-iridium bar, can be made with an accuracy of one or two parts in 10 million. But the accuracy is limited primarily by the widths of the lines on either the primary or the secondary standards which are compared with it.

The International Conference on Weights and Measures has approved the substitution of the wavelength of some suitable atomic radiation in place of the physical standard, the meter bar. A committee has been appointed to consider defining the meter in wavelengths of light, to decide which isotopic radiation would be best, and to specify the conditions for its excitation.

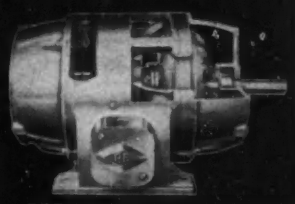
Time. The present unit of time is the mean-solar-second. This is an imaginary quantity computed by astronomers from their observations of the time it takes for a fixed start to cross a meridian; any one such observation can be made with an accuracy of a few milliseconds.

Frequency. The precision possible in the measurement of frequency has been pushed to a high order. Radio engineers are now hopeful that greater accuracy can be met by some form of "atomic clock," in which the standard of frequency is that of some molecular or atomic vibration.

Mass. No changes in the unit of mass can be anticipated for a long time. To produce an atomic standard of mass which would be analogous to optical wavelengths and molecular fre-

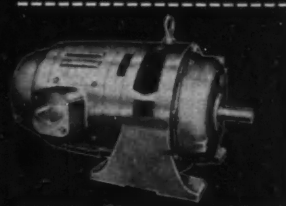
motor design problem?

...maybe one of these REULAND "specials" will solve it!



FLUID-SHAFT MOTOR

Motor with internal fluid coupling. Provides smooth load acceleration. More compact than separate motor and coupling. Assures perfect alignment. Will start heavier loads than standard motors of same horsepower. Used on cranes, conveyors, mixers, etc.

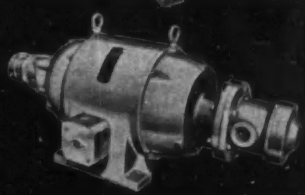


FLUID-SHAFT MOTOREDUCER

Consists of Reuland Fluid-Shaft motor and gear reducer as one compact unit. Converts the motor's conventional high speed into a slow speed, high torque output. Provides smooth starts. Prevents equipment jamming. Used on cranes, hoists, car pullers, etc.

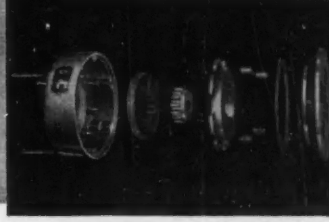
RIGHT-ANGLE MOTOREDUCER

Consists of Reuland motor and worm gear reducer. Provides unlimited mounting versatility. Permits use of 1 high speed and 2 slow speed power-take-off shafts, if desired. Ideal for designing into cramped quarters. Also available with Fluid-Shaft drive motor.



HYDRAULIC PUMP MOTOR

Special end bell flange permits direct, end bell mounting of all standard makes of pumps. Eliminates need for special mounting platforms. Assures absolutely perfect alignment with pump shaft. Available with mounting flange on one or both ends.



THROUGH-SHAFT MAGNETIC BRAKE

"Doughnut" type design allows extension of shaft entirely through brake. Permits use of TWO output shafts per motor. Can be mounted on the input or output shafts (or both) of Fluid-Shaft motors and motoreducers. Only 6 major parts... self adjusting... half usual length.

OVER 600 SPECIAL ELECTRIC MOTOR DESIGNS

Whatever your drive problems may be, there is a good chance that the Reuland "library of specials" contains a unit that is already tailored to your needs. Its availability will save you development work and put you in production faster.

Write today, outlining your particular problem. No obligation, of course.

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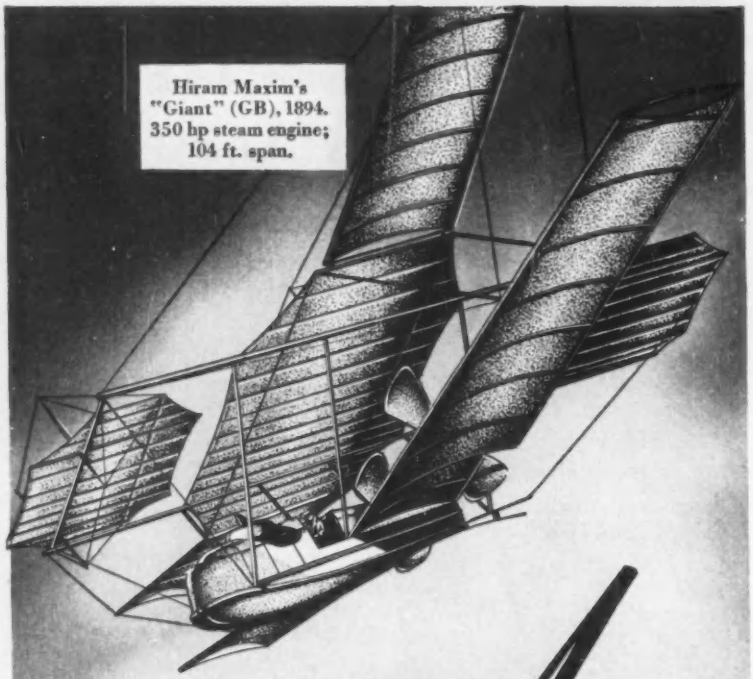

...out of this came Aviation

An industry whose tremendous growth has forced the continued expansion of the manufacturing facilities of many companies to feed this great industry's carnivorous appetite for production.

Indiana Gear Works is such a company—we began to produce precision parts for the aviation industry in 1933.

Today, twenty years later, we find ourselves continuing to increase our physical plant in order to gain the production capacity we need to consistently produce quality precision parts and assemblies.

The manufacturing facilities of IGW at Indianapolis

INDIANA GEAR

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quencies, means must be developed for counting the number of atoms or protons in a microscopic block of material. As there are approximately 10^{23} atoms in one gram of hydrogen, such a counting procedure would be difficult.

Force. By general agreement for metrological purposes, the standard value of g is 980.665 cm./sec.^{2}. This figure is a close approximation to the value of g at 45 deg latitude and at sea level. For more accurate work, it is necessary to use the actual value of g at the place where the force is to be measured. By combining all available data, it is concluded that, for precise work, a value smaller than the Potsdam value by about 15 ppm. should be used.

International Electrical Units. From 1894 to 1948, use was made of an auxiliary set of units known as the International System. These international units of an ohm and volt were defined by the resistance of a column of mercury of specified mass and length and by the rate of deposition of silver from a silver-nitrate solution. In 1946 the International Committee on Weights and Measures abandoned the International System and put into use effective January 1, 1948 electrical units based on absolute measurements.

Absolute Electrical Measurements. There are two types. In the first, an inductor of computed inductance is used in an electric circuit supplied with a periodically varied current, and the effective reactance of the inductor at the known frequency of the current is compared with the resistance of a standard resistor. The result is the determination of the resistance of the standard resistor in terms of length, frequency, and permeability.

In the second type, a pair of coils of known dimensions is constructed and arranged so that the force or torque exerted between them when carrying a current can be measured precisely. This apparatus is called a current balance. As a result of this type of measurement, the value of the electromotive force of the standard cell can be computed in absolute volts.

From the ohm and the volt as a basis, the other electric and magnetic units are derived.

Temperature. The fundamental basis for temperature measurement is the thermodynamic scale proposed by Lord Kelvin in 1854. The accuracy

of realization of this scale over much of its range is approximately 0.05 deg. C.

For many purposes it is important to hold constant temperatures to considerably greater accuracy. To accomplish this, an International Temperature Scale has been developed and adopted internationally. The scale is defined by six fixed points and the indications of interpolation instruments, calibrated at the fixed points according to a specified procedure. Scale changes are now under consideration.

One impending change is the use of the triple point of H_2O to replace the ice point. The triple point is taken to be +0.0100 deg. C.

Another development is the use of the Johnson noise, which occurs in circuits as a result of the Brownian motion of the electrons. Since this motion is a function of the absolute temperature, it is theoretically possible by electronic techniques to measure absolute thermodynamic temperatures.

Another impending fundamental change that will affect the absolute thermodynamic scale is the proposal that the scale be fixed by assigning a definite value for the triple point relative to the absolute zero, and deriving the size of the degree from this. The assigned value will be chosen to make the new degree the same size as on the present Kelvin thermodynamic scale.

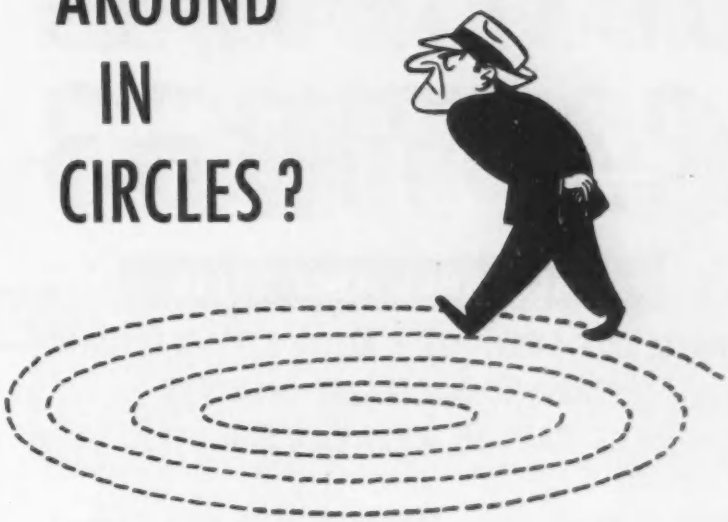
Tolerances and Specifications of Malleable Castings

Abstracted from "Tolerances and Specifications of Malleable Castings" by James H. Lansing, Technical and Research Director, Malleable Founders' Society, Cleveland, Ohio. *Mechanical Engineering*, August, 1953.

GOOD MALLEABLE-CASTING DESIGN will accomplish a three-fold purpose: (1) make for full use of the inherent properties of malleable iron, (2) make for economy in manufacturing, and (3) produce parts that will function most satisfactorily under service requirements.

Of at least equal importance to the engineer-designer are the properties of the material under consideration. In the case of malleable iron, the structure is uniform throughout—a matrix of ferrite in which are interspersed modules of temper carbon—with the

GOING AROUND IN CIRCLES?



Wondering about . . .
the right plastics material?
the right method?
the proper design?
then let WATERTOWN help you!

Here at Watertown you'll find the answers to your plastics problems. Complete design, engineering and production facilities . . . the capacity to see any custom molding job through . . . from idea to delivery . . . regardless of size or shape . . . in any thermoplastic or thermosetting material . . . by the *right* process . . . compression, injection, or transfer. Why struggle with your plastics problems when it's so easy to get the help you need merely by writing to . . .

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MALLEABLE AND STEEL

MALLEABLE CASTINGS • ALLOY STEEL CASTINGS
PEARLITIC MALLEABLE CASTINGS
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Modern Mechanized Foundries... Quality Control Production... Metallurgical Research Laboratory ...Technical Center...Engineering Facilities... Physical Testing and Product Development

THE NATION'S LARGEST INDEPENDENT PRODUCER OF MALLEABLE AND PEARLITIC MALLEABLE

Foundries Located in
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NATIONAL MALLEABLE AND STEEL CASTINGS
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exception of an unimportant decarburization at the surface.

Recently, the question was raised as to the effect of machining on malleable iron. Tests on bars of 0.645 dia, machined to 0.505 in., gave an average drop in ultimate strength of about 10,000 psi and an increase in yield of about 300 psi, as compared to as-cast bars. Elongation in 2 in. decreased 1.2 percent.

In addition, tests made by the Massachusetts Institute of Technology and the Link-Belt Company established the fatigue-endurance ratio of malleable to be in excess of 50 percent and the notch-fatigue ratio to be the relatively high value of 33 percent.

Tolerances

Standard draft allowance for production patterns is $\frac{1}{64}$ in. per in., this being less than 1 deg as compared with 7 deg in some production processes. In certain cases, $\frac{1}{32}$ in. is recommended for the first inch, $\frac{1}{64}$ in. per in. thereafter. If loose patterns are used, the allowance should be substantially greater, for example, approximately $\frac{1}{4}$ in. per ft for loose patterns with a deep draw.

In general, size tolerances should be at least one half the maximum shrinkage allowance. Malleable shrinkage allowance is normally $\frac{1}{8}$ in. per ft, so the size tolerance would be $\frac{1}{16}$ in. per foot. Where extreme accuracy is necessary, malleable iron castings are die-straightened.

Finish Allowances

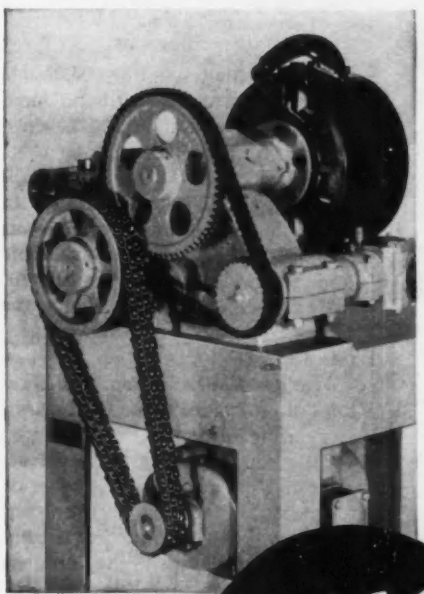
Since malleable iron machines more easily than most other ferrous metals, generous finish allowances do not necessarily mean increased finishing cost. For castings that are not press-straightened, recommended allowances would be as follows:

For milling: $\frac{1}{16}$ to $\frac{3}{32}$ in. for small castings, $\frac{1}{8}$ to $\frac{3}{16}$ in. for medium castings, and somewhat more for large castings.

For reaming: $\frac{3}{32}$ in. on the diameter for cored holes under 1 in., $\frac{1}{8}$ to $\frac{3}{16}$ in. on the diameter for medium holes, and more for larger holes.

Allowances may be considerably less than the foregoing for castings that are press-straightened. In turning or boring diameters larger than 5 in., it is well to allow $\frac{1}{4}$ to $\frac{3}{8}$ in. on the diameter. If locating points are a considerable distance from the ma-

"Yes, but what will it do for me?"



THAT's a fair question for you to ask any manufacturer—and it's a question the Veelos sales engineer wants to answer. Basically the facts are these . . .

- When you design with Veelos v-belt in mind, *you fit the belt to the drive—not the drive to the belt.*
- The motor is placed at the most effective position. You don't need to bother with take-up devices—fixed center drives of any length are practical.
- Idlers and pivoted or sliding motor bases are unnecessary.
- You can use outboard bearings to advantage because Veelos is installed *without dismantling any part of the machine.*
- Your drive will provide vibrationless, full power delivery because correct tension can be maintained for each belt by just adding or removing links.

Yes, these are the basic facts on Veelos, the adjustable v-belt—facts that make your designs more effective.

Veelos v-belt is made in all standard widths: 00, 0, A, B, C, D, and E; double V in 0, A and B. Available in three types: Regular, oil-proof and static conducting.

VEELOS
THE LINK
V-BELT

Do you have these facts on Veelos handy? We'll be glad to send you a copy of this VEELOS DATA BOOK. And remember too, our engineers may be able to help answer your drive questions—so send them along.

MANHEIM MANUFACTURING & BELTING COMPANY
610 Manheim Street, Manheim, Penna.

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

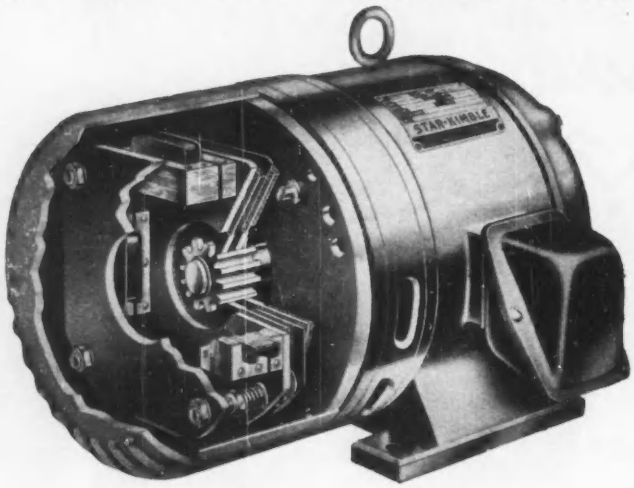
STOP! START STOP! START STOP! START STOP!

START STOP! START STOP! START STOP! START

START STOP! START STOP! START STOP! START

Instantaneous Drag-free

STOPS! STARTS



STOP! START STOP! START STOP! START STOP!

minute after minute YEAR AFTER YEAR
with Star-Kimble Brakemotors

That extra-large brakelining area you see brings a Star-Kimble Brakemotor and its connected load to an *extra-fast stop*—as short as a fifth of a second from full speed to standstill if desired.

And the small air gap contributes to *equally fast starts*. Brake is released the instant motor current is switched on—equipment starts without drag.

That's the story of a *single* Star-Kimble stop-start cycle. And the experience of user after user *proves* that Star-Kimble Brakemotors *maintain* the same split-second stops, the same smooth starts, through hundreds of thousands of cycles. In reversing service, conventional plugging methods with a typical 5 hp motor allow only 3 starts per minute. With a Star-Kimble Brakemotor, the figure is boosted to 10!

Of course, every Star-Kimble Brakemotor is a compact, integral unit designed to save space—and give rugged, dependable performance. One manufacturer—one responsibility.

For the full story, write for Bulletin B-501-A

STAR-KIMBLE
MOTOR DIVISION
EHLE PRINTING PRESS AND MFG. CO.
Bloomfield Avenue Bloomfield, New Jersey

chined surface, additional allowance should be made.

How the castings are to be jigged or chucked is of importance when the amount of finish allowance is being established. The foundry should be given this information, or locating points should be indicated on the drawing. Jigs should never be located from a point where a gate or feeder has been ground off; preferably, they should be on the same side of the parting line—not at the parting line. They should be located where they will not be influenced by the shift of a core and should be as far apart as possible. Dimensions that have no finish allowance, and are to be held to close limits, should be considered as the proper place from which to start the development of tooling fixtures.

When close tolerances are required on certain dimensions, the foundry should always be advised of these dimensions. By making slightly greater allowances on other less important dimensions, it may be possible to hold the important ones with great accuracy. If the quantity involved warrants the production of dies, the close tolerance may be even further reduced.

Specifications

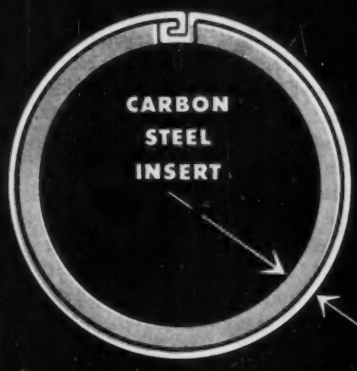
Standard Malleable Iron. Malleable iron castings are customarily produced to ASTM Specification A 47 which provides for two grades.

Military specifications closely approximate ASTM requirements. In neither case are chemical requirements specified. This is because in malleable iron certain elements may be substantially varied in amounts as long as the proper relationship is maintained between them.

Pearlitic Malleable Iron. Modifications of normal malleable iron, known as pearlitic malleables, are produced for use where wearing properties accompanied by a reasonable amount of toughness are required. In these castings part of the carbon is in the combined form. Briefly, the ultimate strength varies from between about 60,000 to 90,000 psi, the elongation in the former averaging around 12 percent and in the latter not more than 3 percent. The type of material to be specified within the ranges depends upon the use to which the material is to be applied.

In general, pearlitic malleable has a higher average yield point and ulti-

VAN HUFFEL ARCHITECTURAL TUBING



here's the tubing

OF A THOUSAND USES

Van Huffel stainless clad tubing combines strength and rigidity with protection from rust, corrosion and excessive wear.

Using stainless steel lock seam tubing for the outer shell and inserting open seam carbon steel tubing provides the special advantages of solid metals at considerably less cost.

Ideally suited for bus stanchions and grab rails; cafeteria tray slides and railings; or wherever beauty, strength, protection and economy are requisites.

Available in sizes ⅝" O.D. to 1.9" O.D.; Stainless Gauges .018 to .035; Insert Gauges .035 to .078.

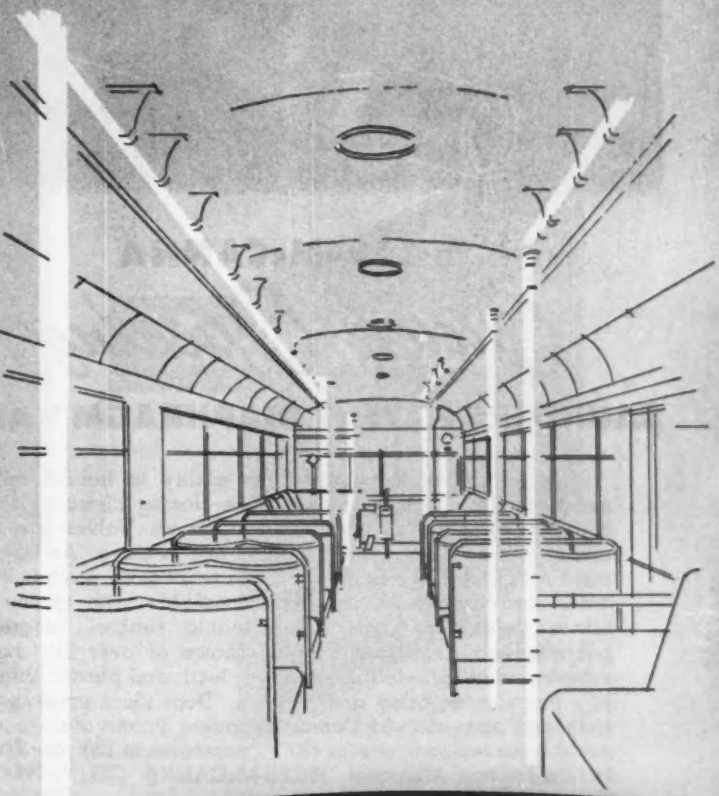
THE ONE TUBING WITH THESE FOUR ADVANTAGES

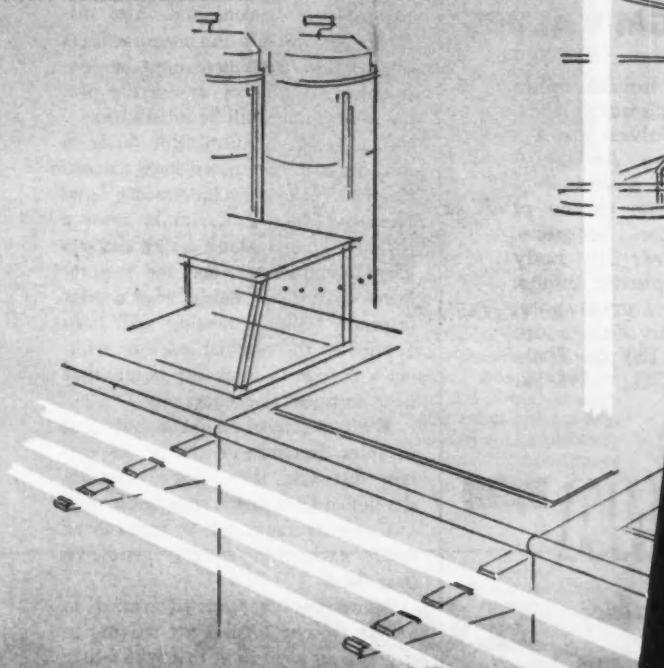
BEAUTY – The stainless steel outer shell provides attractive appearance.

PROTECTION – Never any rust or corrosion to worry about.

STRENGTH – The carbon steel insert supplies the "backbone."

ECONOMY – Costs considerably less than solid metals.





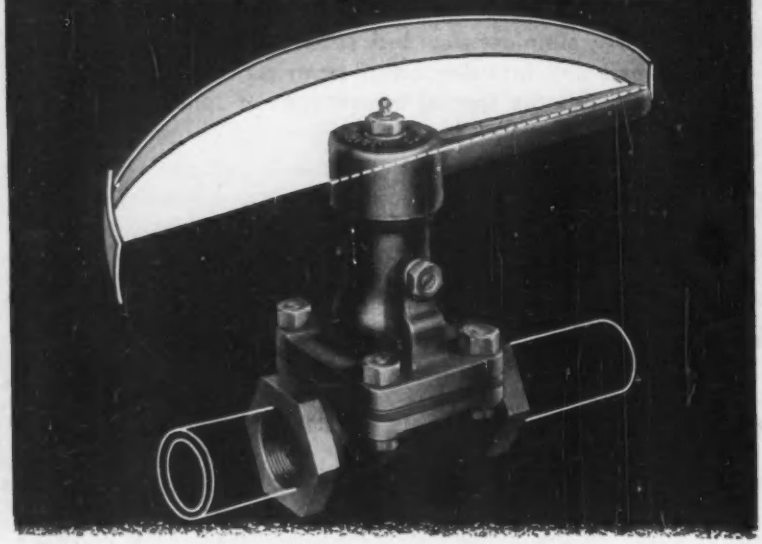
Van Huffel

TUBE CORPORATION · WARREN, OHIO

WHERE IDEAS TAKE SHAPE IN METAL
FOR THE INDUSTRIES THAT SERVE THE NATION

with this corrosion resistant valve . . .

YOU GO FROM FULL OPEN TO FULL CLOSED IN A 180° SWING OF THE LEVER



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Quick Opening

SAUNDERS PATENT DIAPHRAGM VALVES

Where you must combine the ability to handle tough services with quick opening—quick closing characteristics, Hills-McCanna Lever operated Diaphragm Valves are the answer. The lever action is smooth and positive. An adjustment for holding the handle in an intermediate position provides throttling when required. Available with choice of fifteen diaghragm materials including rubber, neoprene, polyethylene, Kel-F and Teflon. Choice of over fifty body materials that include rubber, glass, lead, and plastic linings, any machinable alloy and plastics. Dependent upon materials and size, Hills-McCanna Saunders Patent Valves are suitable for temperatures to 400°F., pressures to 150 psi. Write for descriptive literature. HILLS-McCANNA CO., 2444 W. Nelson St., Chicago 18, Illinois.

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saunders patent diaphragm valves

Also Manufacturers of Proportioning Pumps
Force Feed Lubricators • Magnesium Alloy Sand Castings

mate strength and lower elongation that normal malleable iron. It machines less readily and has a higher indentation hardness. When compared with drop forgings and steel bar stock of identical Brinell hardness, pearlitic malleable may be machined in less time, with greater tool life, and at less cost. In comparison with forgings, it also possesses the general advantages inherent in a cast apart.

The American Society for Testing Materials specification for pearlitic malleable iron castings, A 220, provides for five grades.

Synthetic Hydraulic Fluids

Abstracted from a paper "The Effect of Synthetic Fluids on Hydraulic Components and Circuits" by James Robinson, presented at the National Conference on Industrial Hydraulics, October 8, 1953.

ENGINEERS must seek the answers to two basic questions before being satisfied that the application of synthetic fluids is suitable for the machine tool industry. First, can this fluid be used satisfactorily from a working standpoint? Second, what changes, if any, must be made to the machine or other hydraulic circuit to insure satisfactory performance? No one source may be able to supply the answers. If the fluids are chemical mixtures, then chemists must be consulted. Also, machine tool builders and manufacturers of hydraulic equipment must be consulted as to whether or not the proposed new fluid will be satisfactory.

The use of nonflammable fluids in machine tools has shown some remarkable results. These achievements, however, did not result simply from a change in fluid. Many design changes have been made to suit the requirements of the new fluids. Had similar ingenuity and engineering skill been applied to the original machine without a change in fluid, the results may have been just as encouraging.

Without careful design analysis, and in most instances a change in certain materials, there is no presently developed fluid that is compatible with available hydraulic oils or that can be freely exchanged with a petroleum base fluid.

Many manufacturers interested in selling hydraulic fluids are striving to produce an ideal fluid that will satisfy the sometimes conflicting dreams of

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is the start of a versatile new family of paper base, phenol laminates for use in high quality electronic components requiring the ultimate in insulation resistance.

Taylor XP-400
is the start of a versatile new family of cold-punch, paper base phenol laminates having good electrical properties.

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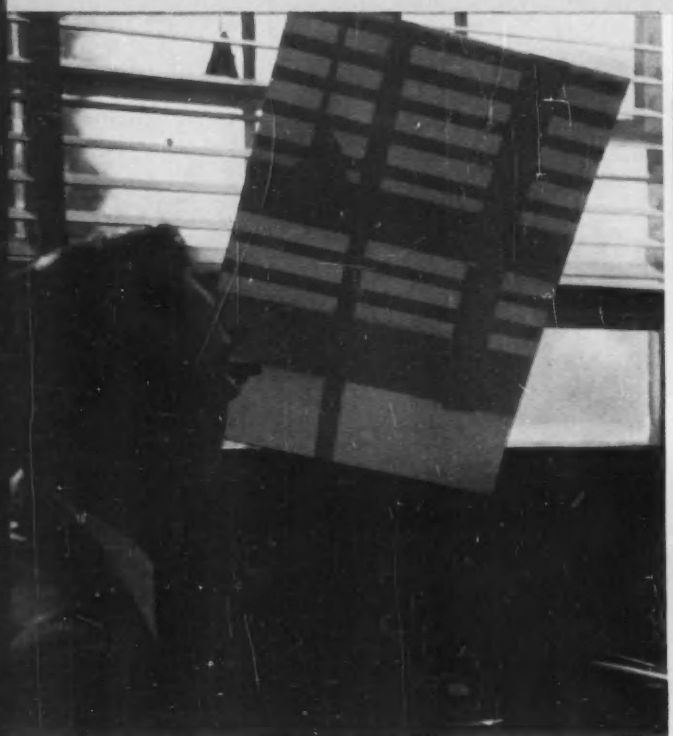
Turn the page for detailed information of value to Management, Engineering, Production and Purchasing...

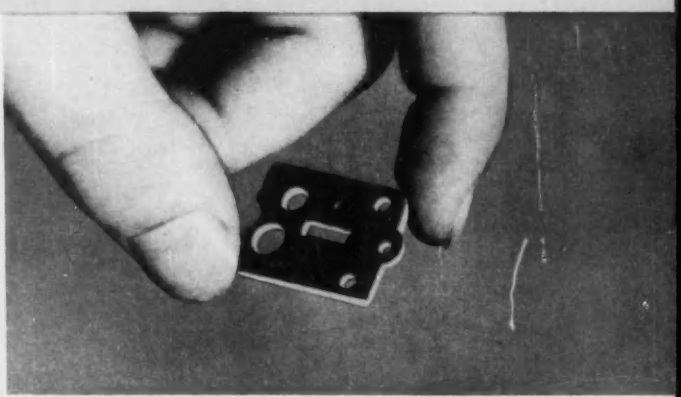
Here's why you'll want to use

XXXP-300

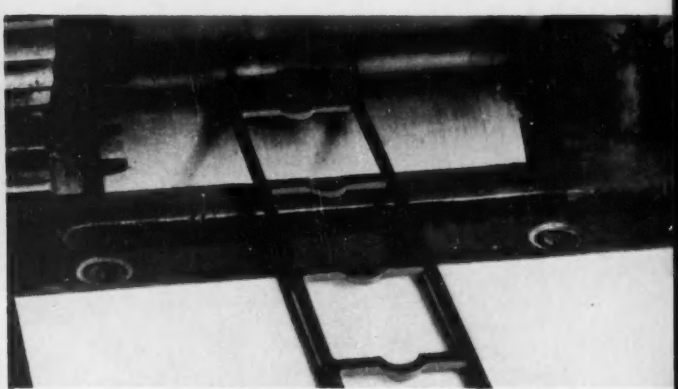
A completely new development, in both formulation and production, in the field of laminated plastics. . . . Extends the use of fabricated parts for a growing list of applications where high insulation resistance is a critical factor, yet meets the most rigorous *staking* and punching requirements. . . . Combines the most desirable specifications with an incomparable ease of fabrication that spells economy all along the line.



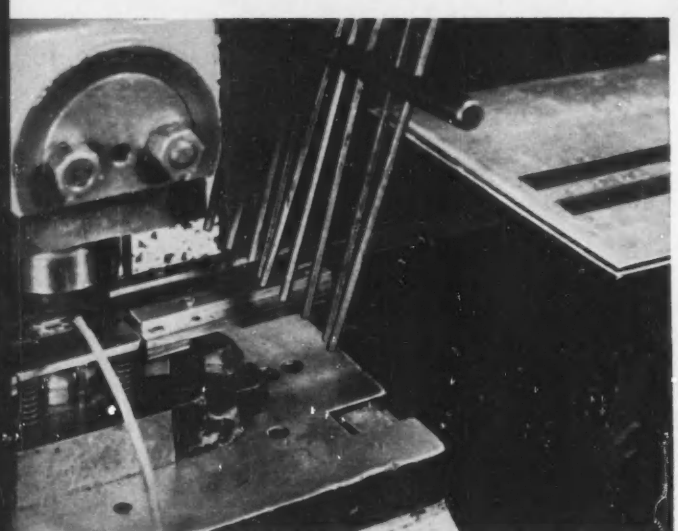
Sheet uniformity, directly related to punching quality, is demonstrated by the clear translucency of this material.



Smooth surface and clean-cut edges show absence of drag, raising, bulging and cracking with NEMA test die.*



Clean, smooth edges of unmarred ladder indicate ease of fabrication under satisfactory temperature conditions.



Continuity of good, clean punching means uninterrupted production—no waste, higher operating efficiency.

XXXP-300 offers you

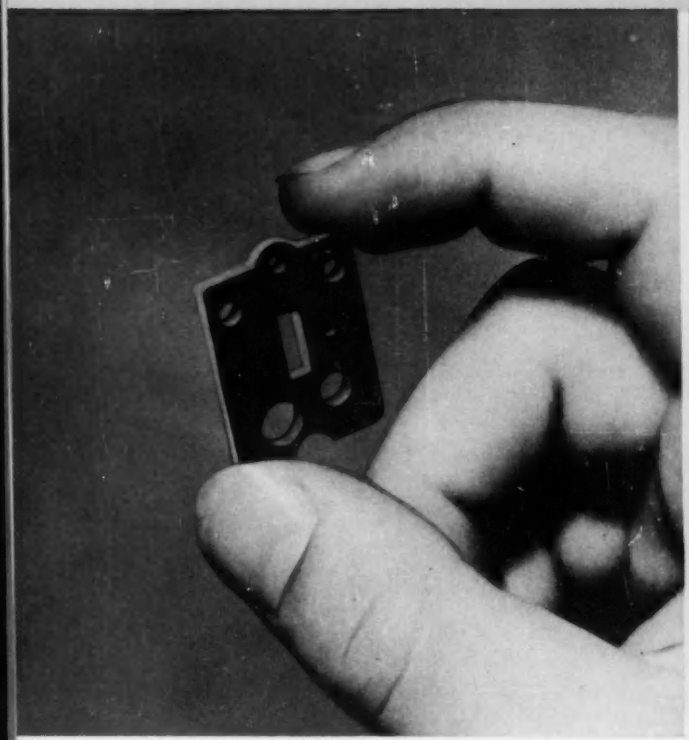
- excellent electrical properties
- low water absorption
- high dimensional stability
  —excellent *staking*
- low power factor
  —high insulation resistance
- flame retardance

and, punches perfectly at 135°C.

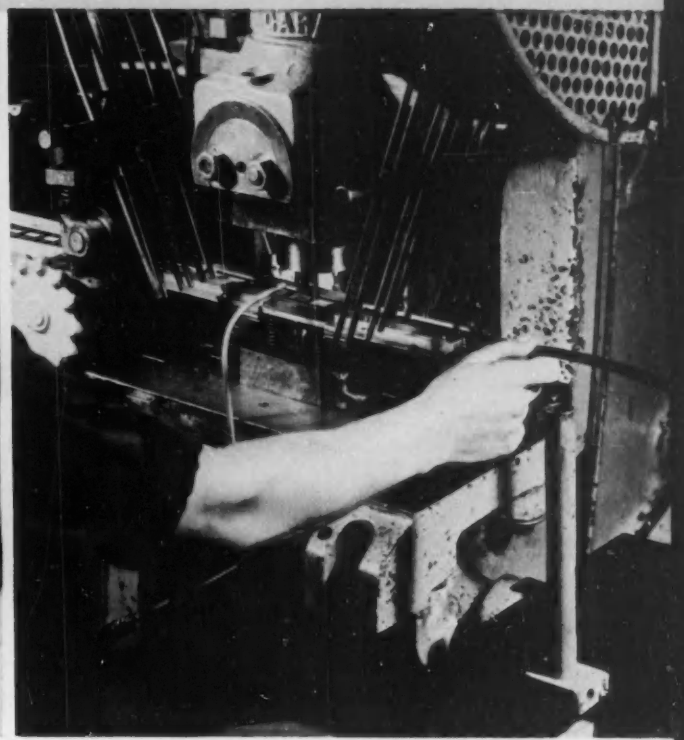
these two new Taylor Laminates

XP-400

A successful solution to the need for a true cold-punching laminate, one that actually punches without the addition of heat. . . . Brings a new ease of fabrication to the mass production of punched parts for thousands of applications. . . . Affords new opportunities for uniformity and efficiency in fabrication, resulting in a radical reduction of waste and the practical elimination of rejects.



Cold-punching from NEMA test die—holes are clean-cut, surface is smooth, edges show no chipping.*



The complete absence of heat in this operation demonstrates the practicability of true cold-punching.

XP-400 offers you

- low water absorption
- flame retardance
- excellent *staking*
- good impact strength
- high dielectric strength

and, punches perfectly at room temperature

Both of these new Taylor Laminated Plastics are the result of years of study and experience, *plus* 16 months of intensive research and development. They are now available in production quantities for applications where an outstanding combination of physical and electrical properties is required.

Sheet size: 49″ x 49″.

*National Electrical Manufacturers' Association

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Laminated Plastics
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TURN THE PAGE FOR COMPLETE SPECIFICATIONS

Look . . . at the properties of these new materials . . . compared to NEMA standards! They are your guarantee of top performance, and it costs no more to get them

NEMA GRADE	TAYLOR GRADE	SPECIFIC GRAVITY	WATER ABSORPTION D/24/23	FLEXURAL STRENGTH THOUSANDS OF psi		TENSILE STRENGTH THOUSANDS OF psi		COMPRESSIVE STRENGTH THOUSANDS OF psi FLATWISE	IMPACT STRENGTH IN FOOT LBS. CONDITION E/48/50		ROCKWELL HARDNESS M SCALE	POWER FACTOR				DIELECTRIC CONSTANT				DIELECTRIC STRENGTH - VPM		DIELECTRIC STRENGTH PARALLEL KV STEP BY STEP		INSULATION RESISTANCE CONDITION C96/35/90 MEGOHMS	Run according to underwriters test by our own lab. FLAME RETARDANCE IN SECONDS		PUNCHING QUALITY	4000 psi FOR 24 HRS. AT 50°C. COLD FLOW
												COND. A		COND. D/24/23		COND. A		COND. D/24/23									
				LW	CW	LW	CW		LW	CW		1MC	60 CYCLE	1MC	60 CYCLE	1MC	60 CYCLE	1MC	60 CYCLE	SHORT TIME	STEP BY STEP	COND. A	COND. D/48/50		FW	20° ANGLE		
P	⅛"		1.33*	2.80	13	11	12*	9*	25*	0.55	0.50	M95*									⅛" TK 650*	⅛" TK 450*	40.0	5.0					
PC	⅛"		1.34*	4.00	10	8	10*	8*	22*	0.60	0.55	M75*									⅛" TK 600*	⅛" TK 425*							
	⅛"	XP-400	1.31	.70	13	11	12	9	25	0.66	0.62	M80									698	505	62.5	16.0		2	45	GOOD	
XXXP	⅛"		1.30*	1.00	12	10	12*	9*	25*	0.35	0.30	M105*	.030		.035		4.60		4.80		650*	450*	60.0	15.0	20,000*				.8%*
	⅛"	XXXP-300	1.35	.50–	20	17	13	11	40	0.44	0.42	M105	.027	3.0%	.029	5.0%	3.72	4.18	4.75	5.15	800	670	65.+	59.+	300,000	8	40	GOOD	.6%
	⅛"	XXXP-301	1.32	.50–	18	14	13	10	31	0.47	0.44	M108	.026	2.7%	.028	6.0%	3.55	4.19	3.84	4.63	920	725	75.+	65.+	300,000 +	34	44	VERY GOOD	.6%

*NEMA engineering information only, not a standard

With these two new materials, the electrical and electronics equipment designer has new advantages he can build into his products. The production man can effect new economies through ease of shearing and punching and greater uniformity of fabricated parts with excellent *staking* characteristics. Here are two new families of Taylor made laminates each of which can be "Tailor Made" for you!

For all your requirements of Phenol, Melamine and Silicone laminates . . . as well as Vulcanized Fibre . . . try Taylor today and you'll standardize on Taylor tomorrow. The complete line of Taylor materials is available in a wide range of electrical, mechanical and physical properties. Taylor Engineers are well qualified to help your staff select the Taylor products best suited to your particular requirements . . . whether you buy raw stocks of sheets, tubes, rolls or rods . . . or specially fabricated parts.

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both the hydraulic engineer and the user of hydraulically operated machines. Much difficulty is presented, however, by the contending demands of the different particular fields. For example, the hydraulic servomechanism field as compared to the industrial machine tool field.

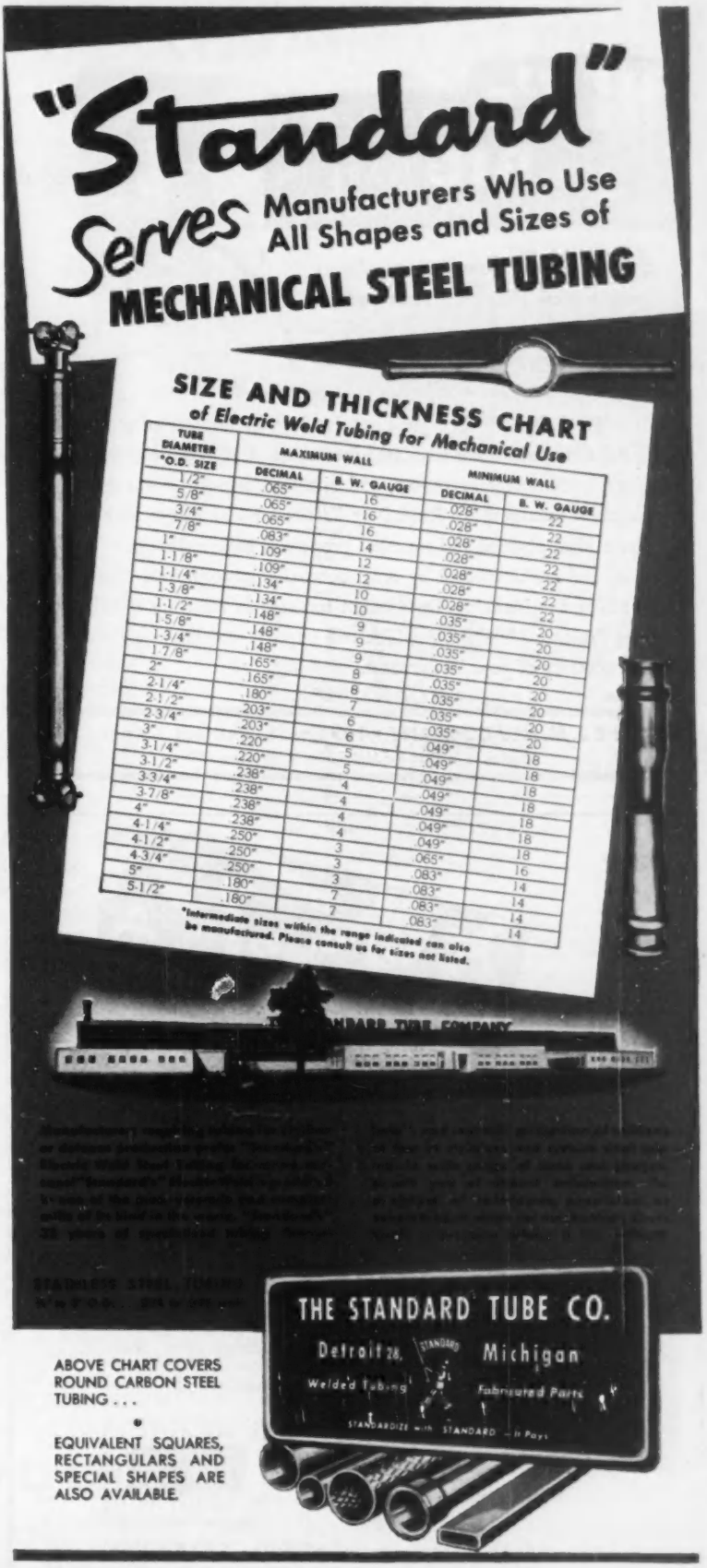
In the former, one particular characteristic in great demand is the bulk modulus. The time required to transmit energy from one portion of an hydraulic circuit to another is a direct function of the bulk modulus of the fluid. The magnitude of this property for present fluids is in the vicinity of 250,000 psi. In servomechanisms, if this value were four times as great, it would be highly beneficial. In the industrial fields, the bulk modulus is still important. Apparently, however, the characteristics of available petroleum fluids are sufficient to satisfy the demands; and while the modulus should not be decreased, no increase is necessary.

The lubricating quality of an hydraulic fluid is probably most important. Today the tendency in hydraulic circuits is towards higher pressures and higher speeds. These two factors dictate that the lubricity must not decrease. If anything, it should advance. In addition, the fluid should have the ability to adhere to metals; for example, on rapidly rotating antifriction bearings. Also, this property should not be obtained at the expense of contributing to the rapid breakdown of ball bearings from spalling, from minute spots of contamination, from small flaws, or from fretting corrosion such as commonly occurs in inadequately lubricated, heavily loaded ball bearings.

While nonflammability is often unnecessary, it would be desirable in all fields of hydraulics providing nothing was sacrificed to obtain this property.

There should be no electrolytic effect between steel and bronze with the new fluid, since this combination of materials is widely used in all types of machines for bearings or wearing surfaces. The new fluid, therefore, definitely should not cause corrosion on any of our stable materials.

In many hydraulic circuits, elaborate precautions must be taken to minimize or eliminate the detrimental effects of foaming. Where space permits, large reservoirs are often used that create a low velocity section in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3/4" .065" 16 .028" 22
7/8" .083" 14 .028" 22
1" .109" 12 .028" 22
1-1/8" .109" 12 .028" 22
1-1/4" .134" 10 .028" 22
1-3/8" .134" 10 .028" 22
1-1/2" .148" 9 .035" 20
1-5/8" .148" 9 .035" 20
1-3/4" .148" 9 .035" 20
1-7/8" .165" 8 .035" 20
2" .165" 8 .035" 20
2-1/4" .180" 7 .035" 20
2-1/2" .203" 6 .035" 20
2-3/4" .203" 6 .035" 20
3" .220" 5 .049" 18
3-1/4" .220" 5 .049" 18
3-1/2" .238" 4 .049" 18
3-3/4" .238" 4 .049" 18
4" .238" 4 .049" 18
4-1/4" .250" 3 .049" 18
4-1/2" .250" 3 .065" 18
4-3/4" .250" 3 .083" 16
5" .180" 2 .083" 14
5-1/2" .180" 2 .083" 14
.083" 14
*Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.
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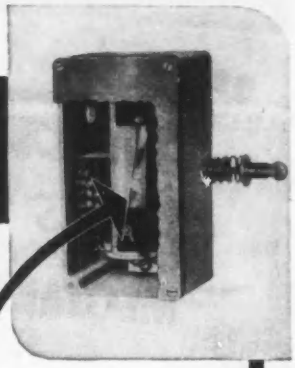

The Ward Leonard Electric Company's New Plunger Potentiometer-Type Rheostat, illustrated at the right, uses a sliding contact made of one of Ney's Precious Metal Alloys.

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The J. M. Ney Company has developed a number of precious metal alloys which are fabricated into contacts, wipers, brushes, slip rings, commutator segments, and similar components for use in electrical instruments. These Ney Precious Metal Alloys have just about ideal physical and electrical properties, high resistance to tarnish, and are unaffected by most corrosive atmospheres. Consult the Ney Engineering Department for help in selecting the right Ney Precious Metal Alloy which will improve and prolong the life and accuracy of your instruments.

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the oil circuit, permitting the natural removal of air or gaseous bubbles. If such construction is not feasible, diaphragms, floating pistons, or completely closed circuits are often utilized to prevent the entrance of air into the oil.

To reduce the complexity of these devices, the ideal fluid should purge itself of air easily. Also, a low air absorption rate is necessary, since the compressibility, particularly at the lower pressures, is directly dependent upon the amount of entrained air in solution. A point of lesser importance would require that the fluid should have a sufficient amount of air absorption to scavenge air from pockets in the circuit.

It is extremely difficult in the operation or maintenance of machines to avoid direct contact with the hydraulic medium; for this reason, the ideal fluid should be nontoxic. This specification should apply also to any vapors or fumes that may be boiled off the fluid.

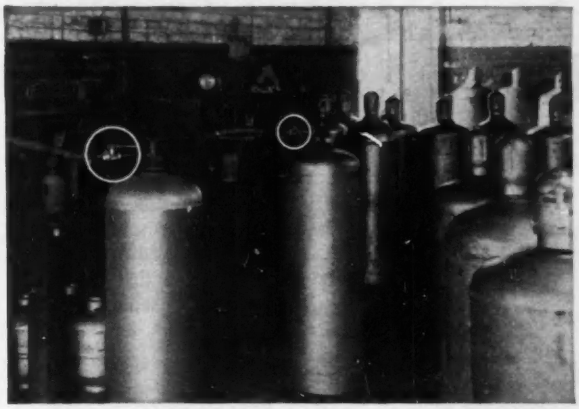
In many industrial applications, very long lengths of tubing or piping are encountered. In these and other applications, a low specific gravity would be beneficial to minimize the power required for acceleration of the fluid and also to minimize the generation of high surge pressures.

While viscosities should be maintained at about the same point as are available in petroleum fluids at normal temperatures, it seems to be desirable to raise the viscosity index. Although extremely low temperatures are not encountered in the machine tool field, a high viscosity index would facilitate fluid flow and permit satisfactory operation immediately upon starting, even after a long weekend of idleness. This high index would also prevent excessive leakage at high temperatures and thus avoid the need for coolers with their usual abnormal waste.

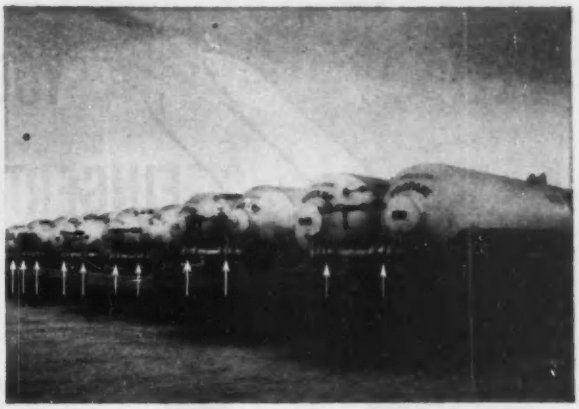
Stability should be maintained independently of temperature and also over extended periods of storage. It should not be necessary to store the fluid in sealed containers or in sealed reservoirs during usage. The viscosity and other physical properties should not be permanently changed as the result of either high pressure or high mechanical shear rates that may be encountered in throttle valves or other forms of orifices.

Realizing that heat exchangers often

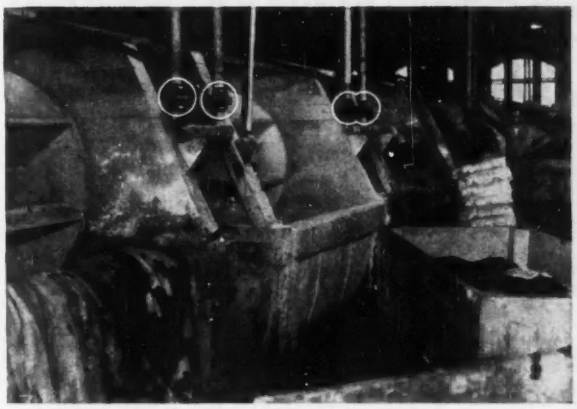
Do you need a LEAKPROOF VALVE?



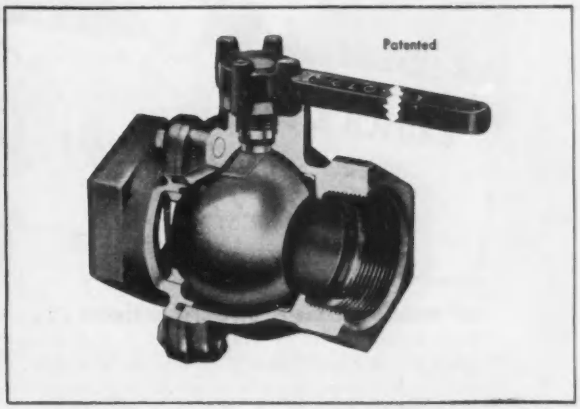
Leakproof in a Propane Plant, where hazards are high and protection is important. Here Rockwood Ball Valves are "far ahead of any others we have used," to quote the maintenance engineer.



Leakproof on LP Gas Trucks, where a whole fleet of trucks carries flammable bottle gas. Operator of fleet reports longer life for valves and generally lower costs since standardizing on Rockwood Ball Valves.



Leakproof in a Tannery where it must stand up under lime and acid vapors constantly. "Rockwood Ball Valves are sure built to take it," says the foreman. "They prevent costly damage to hides from hot water."



Leakproof for Longer Time — because Rockwood Ball Valves are designed to operate under the roughest and most grueling of conditions. They pay for themselves over and over wherever they are in service.

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Full Round Flow — assuring fast, efficient operation, less friction loss.

Quick Opening and Closing — needs only ¼ turn even under full pressure.

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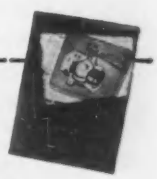
***FULL-FLOW* BALL VALVES**



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- Right Angle Prisms
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are necessary, a high heat transfer coefficient is desirable, thereby permitting the use of heat exchangers smaller than normal. In addition, a high heat transfer coefficient will reduce the temperature differential between the interior and exterior of hydraulic equipment thus permitting more radiation by natural means.

Fluids, other than those with a water base, including any additives, should be nonhydroscopic so that any water introduced by condensation or other means would remain separately as water.

While most machine tools have a relatively small temperature range, a low coefficient of expansion with temperature is desirable to eliminate the necessity for maintaining large expansion chambers.

While it is very desirable to completely separate hydraulic fluid from electric components, the fluid must have good insulating properties to permit the immersion of electric equipment. If the fluid would permit the passage of electric current, galvanic corrosion of exposed dissimilar metals would probably occur. In the event of saturation of electric wiring, the fluid should not cause a decrease in the dielectric strength of insulating materials.

Metals for Atomic Reactors

Abstracted from a paper by William A. Johnson of the Atomic Power Division, Westinghouse Electric Corporation, as presented at the Second Annual Conference, "Atomic Energy in Industry," National Industrial Conference Board, Inc., New York City, October 29, 1953.

THE MAJOR NEW REQUIREMENT with respect to engineering materials is resistance to radiation damage. Fortunately, just as the properties of metals can be altered and optimum combinations of properties obtained by conventional metallurgical techniques of alloying, heat treatment and mechanical working, so also can the problem of radiation damage be attacked. The primary difficulty of the reactor metallurgist is not the unusual combination of engineering properties required for a variety of applications—strength, ductility, corrosion resistance, freedom from excessive radiation damage—but rather the limited choice of metals available from which to develop a so-

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but this

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(EXCLUSIVE IN SEALMASTER BEARINGS)

can end two main causes of bearing failure

Dirt or loss of lubricant can quickly grind the life right out of the finest bearings. SEALMASTER'S *unique double sealing principle protects you against both.* It's your best insurance against needlessly high maintenance costs and losses from machine downtime!

In SEALMASTER Bearings grooved steel inner seals assembled right into the outer race ring, on each side of the ball chamber, form the grease chamber.

Felt-lined steel flingers rotating in the grooves of the inner seals positively prevent dirt from entering the bearing. At the same time, the bottom flanges of these flingers, extending under and beyond the inner seal, create a vortex that breaks the grease flow and retains proper amount of lubricant.

Even if your bearings do not have to take the abuse of "dirty jobs," you need the protection of the SEALMASTER seal. In *any* bearing application, it is your protection against needless maintenance costs . . . it helps keep your machines running longer, better.

Why not write now for full information in our Bulletin No. 845.

". . . if you slip up by skipping lube periods, using the wrong lubricant, letting dirt into the bearing, you'll run into a string of bearing failures. Bearings have no way of yelling for help if they don't get the right attention. They'll just sit tight and take it . . . until they fail."
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Subject: *GRANODIZING** FOR LONG PAINT LIFE ON STEEL

"GRANODINE" FORMS A DURABLE PAINT BOND

Granodizing forms a crystalline, zinc phosphate coating on steel. This ACP paint-bonding process chemically changes the surface of steel into an inert non-metallic coating made up of thousands of microscopic zinc phosphate crystals.

Granodized steel thus presents a surface much more receptive to paint than untreated steel. Its crystalline structure permits a firm and durable "keying" or bonding of the paint finish. And the "Granodine" zinc phosphate coating itself is actually integral with the metal from which it is formed.

"GRANODINE" CAN BE APPLIED BY DIPPING, SPRAYING OR BRUSHING

Granodizing can be accomplished by:

1 Dipping the work in tanks;
2 Spraying the parts in a power washer; or
3 Brushing, spraying, or flow-coating the work with portable hand equipment.

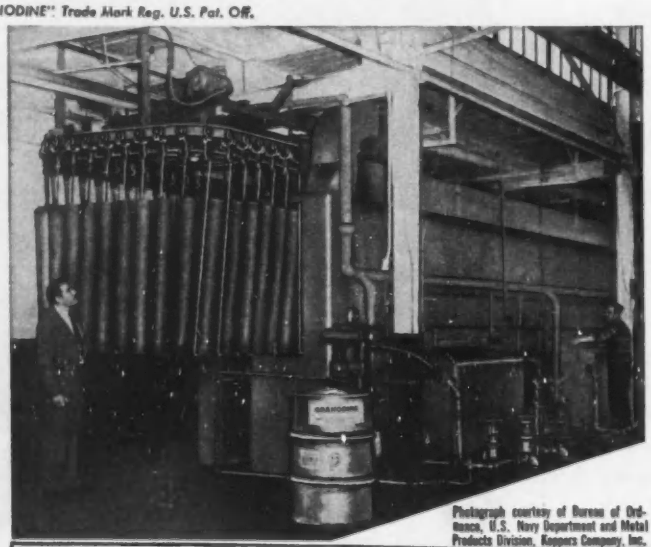
Choice of process is usually decided by such factors as the size, nature, and volume of production.

"GRANODINE" STANDARD PRACTICE ON BOTH CIVILIAN AND MILITARY PRODUCTS

Automobile bodies and sheet metal parts, refrigerators, washing machines, cabinets, etc.; projectiles, rockets, bombs, tanks, trucks, jeeps, containers for small arms, cartridge tanks, 5-gallon gasoline containers, vehicular sheet metal, steel drums and, in general, products constructed of cold-rolled steel in large and continuous production are typical of the many products whose paint finish is protected by "Granodine".

In military production, "Granodine" is used to obtain a zinc phosphate finish meeting Grade I of JAN-C-490 and equivalent requirements of other specifications.

*"GRANODINE" Trade Mark Reg. U.S. Pat. Off.



Photograph courtesy of Bureau of Ordnance, U.S. Navy Department and Metal Products Division, Keppers Company, Inc.

Typical power spray washing machine for the automatic application of a protective phosphate coating to metal parts in preparation for painting. These 5" rocket motor tubes, as well as products made of cold rolled sheet steel, are effectively phosphate coated in such equipment.

CHEMICALS ACP PROCESSES

lution. This limited choice arises from the fact that the metals used in a reactor must generally also serve a nuclear function, or, if they serve no nuclear function, must at least satisfy certain nuclear restrictions.

There are five convenient functional categories into which metals used for the reactor core can be divided. These are: structural materials, moderator materials, control materials, fuel materials, and source materials.

Structural materials serve no nuclear function. They must have a low neutron capture cross section. That this is indeed a restriction can be realized from the fact that none of the major constituents of common corrosion resistant and high temperature alloys—iron, nickel, chromium, cobalt, tungsten, molybdenum, titanium—have thermal cross sections sufficiently low for attractive neutron economy. Intermediate and fast reactors offer more leeway in this respect, and materials like stainless steel can often be used. Of the low cross section metals, only beryllium, zirconium, magnesium and aluminum have potentially useful structural properties. Because of relatively low melting point, poor mechanical properties at only slightly elevated temperatures, and questionable corrosion resistance in desirable heat transfer media, magnesium and aluminum appear unattractive.

Moderator materials serve the nuclear function of slowing down neutrons from the very high energies at which they are born in fission to thermal energies. They must have low atomic weight and low cross section. The only metal satisfying these requirements is beryllium, and so it attracts a two-fold interest. It is to be noted that non-metals, such as hydrogen, deuterium and graphite, are often used as moderators.

Control materials serve the nuclear function of absorbing neutrons in a controlled manner to permit adjustment of reactivity. By inserting or withdrawing such materials, the reactor can be shut down, started up or its power level changed. Materials having very high absorption cross sections are ordinarily used for control purposes. Although most metals have cross sections too high for efficient use as structural materials, only a few have cross sections sufficiently high for efficient use as control materials. Some metals

Half mile of HELIARC TRADE MARK welds OK'D by rigid X-ray tests

A midwest manufacturer was faced with the problem of getting X-ray quality welds in aluminum vessels. These welds were subject to pressure and had to be entirely free from porosity and oxide inclusions. After thoroughly investigating customer specifications, LINDE's service engineers recommended HELIARC inert gas shielded welding for the job.

Since then, about a half mile of these HELIARC welds have been OK'd by 100% X-ray inspections. According to company officials, HELIARC welding was "perfect for the job" and meant real savings by getting X-ray quality welds the first time without expensive rejections or repairs.

Whether you weld aluminum or other hard-to-weld metals, you, too, will find that fast, clean, HELIARC welding will save you time and production costs. HELIARC welding takes place under a shield of inert argon gas which eliminates the need for flux. As a result, HELIARC welds are free from porosity and oxide inclusions. This means fewer rejects and lower finishing costs. In fact, spatter-free HELIARC welds in many cases can be left "as welded."

You owe it to yourself and to your Company to find out more about the cost saving benefits of HELIARC welding. Call your local LINDE representative today. He will be glad to furnish you with detailed information on HELIARC welding.

LEFT Welding heavy aluminum sections with HELIARC *HW-10 torch. These welds were strong, dense, and required little finishing. BELOW The 300 amp.* HELIARC *torch has all-internal water-cooling of both torch head and power cable for cool, long-lasting operation. The HW-10 also features quick electrode adjustment.*

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that have been proposed are cadmium, boron, certain rare earths, gold and hafnium. Cadmium has a relatively low melting point; boron has a high melting point, good resistance to many corroding media, but is rather brittle. If used for reactor purposes, it is likely that these metals will be minor alloying constituents in a base metal of more suitable engineering properties. The rare earths are relatively scarce and expensive, and probably have unsuitable engineering behavior. Gold has the obvious disadvantage of cost. Hafnium perhaps provides the best combination of high cross section with desirable engineering properties.

Fuel materials serve the nuclear purpose of providing fissionable atoms. The most familiar material is U235, which occurs in natural uranium to the extent of 0.7 percent. A less familiar material is U233, which is formed by neutron bombardment of thorium. Finally, there is plutonium, which is formed by neutron bombardment of U238. It is extremely toxic and much care must be exercised to prevent its ingestion in the body. The complications arising from the remote handling usually necessary are considerable, and it has been estimated that the time taken in an experiment involving plutonium may be as much as five to ten times greater than normal experiments in which such precautions are not necessary.

Source materials provide atoms which can be transmuted into fissionable material. As mentioned previously, examples are thorium and U238. Again the choice available is severely limited.

The number of nuclearly desirable metals in each functional category is, as has been seen, quite limited: zirconium and beryllium for structural purposes; beryllium for moderating purposes; hafnium, boron and a few others for control purposes; uranium and plutonium as fuels; and uranium and thorium as source materials. It is not always possible, using a preferred metal, to develop treatments or alloys that satisfy the usual material requirements of strength and corrosion resistance, plus the unusual requirement of resistance to radiation damage. In such cases, the engineering expedient of designing around the difficulty can be used or the nuclear requirement can be compromised.

OUR READERS SAY

Letters should be addressed to The Editor, *Product Engineering*, 370 West 42nd St., New York, 36, N. Y.

Reference Book Sheet A Help

To the Editor:

I have been a regular reader of *Product Engineering* for many years and would like to take this opportunity of thanking you for the high quality that you have maintained in your editorial content throughout the years. Your pages have always been a source of information and enlightment for me. I am thinking particularly of your Reference Book Sheet section, especially your recent article on Radiation Characteristics of Metals (*Product Engineering*, Sept. 1953, p. 205). But not only this section, but your entire magazine is a constant source of reference to me.

—CARL BENSON
New York, N. Y.

Additional Data On V2B

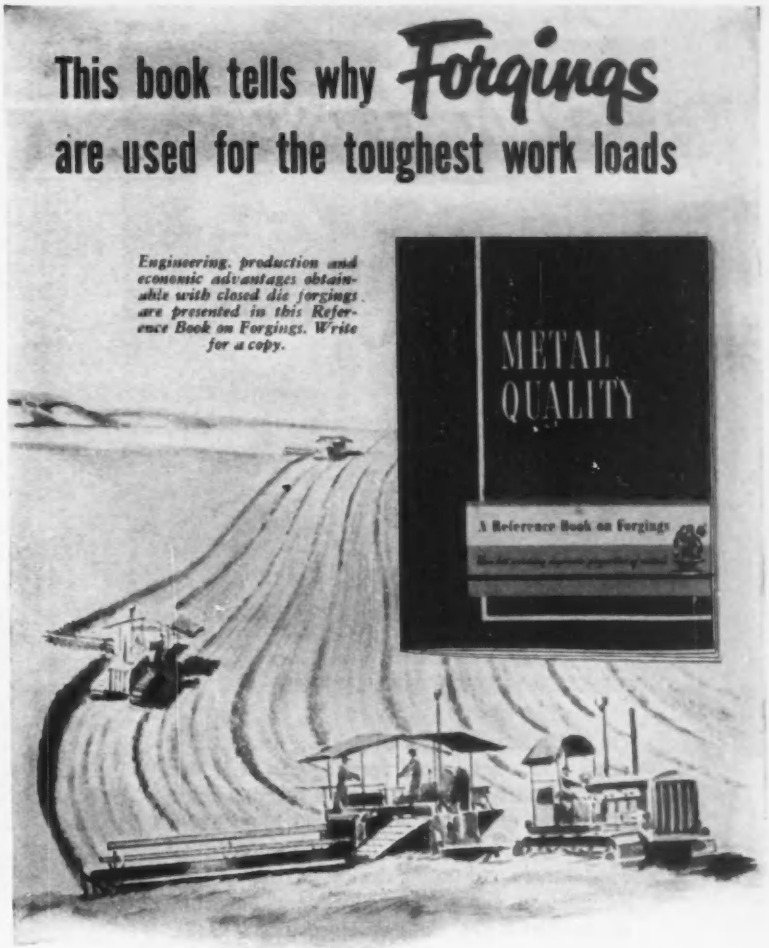
To the Editor:

In the July story in *Product Engineering* on the new, patented V2B Stainless Steel alloy developed by the Cooper Alloy Foundry Co., you neglected to include the nickel content in indicating the composition. To set the record straight we would appreciate your printing the recommended balanced chemical composition range for this new alloy.

Balanced Chemical Composition Range

Carbon			0.07	percent
Chromium	19.0	to	19.50	percent
Nickel	9.75	to	10.25	percent
Silicon	2.75	to	3.25	percent
Manganese	0.50	to	0.75	percent
Copper	2.0	to	2.25	percent
Molybdenum	3.0	to	3.50	percent
Beryllium	0.10	to	0.20	percent

The value of this stainless alloy lies in its excellent corrosion resistance in the hardened state. It was developed


This book tells why Forgings are used for the toughest work loads
Engineering, production and economic advantages obtainable with closed die forgings are presented in this Reference Book on Forgings. Write for a copy.
METAL QUALITY
A Reference Book on Forgings

There is no substitute for the strength and toughness inherent in closed die forgings. A product fortified with the metal quality found in forgings outperforms other products. Check all the aspects of a problem part with the unrivaled economic and mechanical advantages of closed die forgings and the closed die forging process for producing parts. Double-check all parts, particularly those which are subjected to great stress and strain. Then consult a Forging Engineer about the correct combination of mechanical properties which closed die forgings can provide for your product.

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Please send 64-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metal", 1953 Edition.

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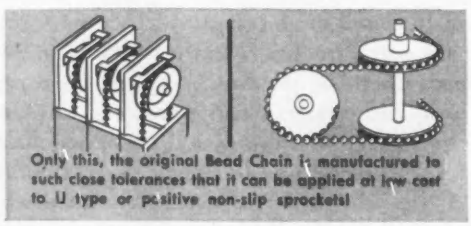

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primarily to overcome the danger of galling and is recommended particularly for parts such as: valve disks, plug cocks, wearing rings, poppets, conveyor links, rollers, gear blanks and other parts requiring both high hardness and corrosion resistance. Hardness and physical properties of V2B are shown below:

Hardness:	*Brinell*
As-Cast	302
Quench Annealed	269
Annealed and Hardened	363
Mechanical Properties:	
Quench Annealed and Hardened	
Tensile Strength,	151,600 psi
Yield Strength,	122,400 psi
Elongation,	3 pct
Reduction of Area,	2 pct

High Temperature Characteristics

Hardness After 50 Hr at Temperature

Temperature Deg F	*Bhn*
Original	340
800	340
900	340
1000	340
1100	302
1200	332
1400	351

Without going into a long discussion of its corrosion resistance in various media your readers might be interested in knowing that it is equal to or superior to Type 316 stainless under most conditions. V2B is available in the cast form from Cooper Alloy and in the various wrought shapes from Crucible Steel. —N. S. MOTT
The Cooper Alloy Foundry Co.

Molybdenum Linings?

To the Editor:

As a subscriber to your magazine, may I ask the following question?

Could not a molybdenum coating on steel blades be used on a "closed turbine" circuit where the heat is conducted from outside to inside through conduction instead of combustion chamber oxidation?

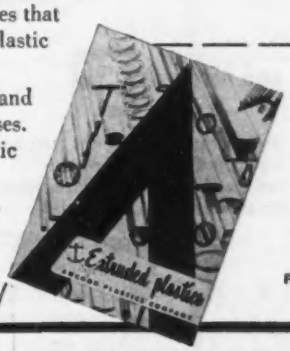
If a circulating current of Helium gas was used, the helium, being non-oxidizing, would not affect the molybdenum, which otherwise resists great amounts of heat.

Is my frame of reference scientifically correct? Especially if molyb-

Plastic **EXTRUSIONS** can be used in your product too! We have just published a 12 page brochure containing 36 illustrated examples that demonstrate how various industries use thermo-plastic extrusions in their products.

You can get ideas of how custom-made rods, tubes and other shapes may be used in your products or processes. The brochure also contains full information on plastic materials, specifications and property tables.

You will find this brochure informative and profitable. *Write for your free copy of* "EXTRUDED PLASTICS" *or clip the coupon and attach to your letterhead.*



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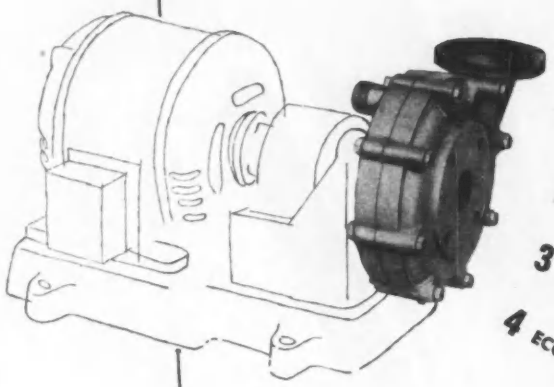

1 CORROSION RESISTANCE

2 STRENGTH

3 DIMENSIONAL STABILITY

4 ECONOMY

...for ACID PUMPS for instance

One of the strongest plastics known . . . .Ace Hard Rubber . . . got the nod for the impeller and casings of this acid pump. Why? (1) It's resistant to almost all corrosives; (2) High strength and abrasion resistance; (3) Won't warp or swell; and (4) Costs much less than corrosion-resistant alloys. Typical result: On one job this hard rubber pump handles 12% hydrofluoric acid, turns on and off twice a minute, 24 hours a day, six days a week . . . a mighty tough test for corrosion-resistant materials?

Many other Ace hard rubber compounds are available . . . tensiles as high as 10,000 psi, moisture absorption as low as 0.04%, power factor as low as 0.006, heat resistance to 300 Deg. F. . . . also many new plastics and rubber-resin blends. All Ace compounds are tailor-made to fit the job . . . never *over*-designed. That's why Ace is the *only* material that meets all four big requirements for parts like acid pumps.

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denum metal lined the inside of casing and turbine blades, while a thin layer of aluminum oxide on the outside of the casing (where heat impinged) would transfer its heat to high grade alloy casing, yet prevent oxidation once the aluminum oxide was heated up.

—DONALD K. ANDERSON

Ed.—Wouldn't it be difficult to form molybdenum into the correct shape and bond it to another material? This is only conjecture, of course; for more definite information we suggest that you write to the Research Laboratories, Climax Molybdenum Co., Detroit, Michigan.

Problems of Construction For Nuclear Research

To the Editor:

You are to be congratulated on the fine article which appeared in the Perspectives Section of *Product Engineering*, October, 1953.

It is gratifying to find that someone has taken a serious look into the production picture of the coming atomic energy era. We have recently completed construction of our second Synchrotron (nuclear particle accelerator) and have encountered all of the problems cited in the article plus many others. Our specifications were extremely rigid and tolerances held to absolute minimum.

There were many suppliers who tactfully asked us to verify our requests, because of the rigid demands. There were even those less tactful manufacturers who doubted our competency and ignored our requests. Nevertheless, we succeeded in completing our construction program ahead of schedule. Most credit is due to the farsighted engineering executives of the few companies which shared in the building program. They allowed us beyond the receptionist and sales department, listened to our requests as well as our suggestions for producing the critical components required by the extremely high energy "atom-smashing" Synchrotron. I doubt whether their cash profits were worth mentioning, however, they all expressed a satisfaction in having produced work of high quality thus gaining confidence toward subsequent orders for precision equipment.

They also earned a rather exclusive

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When desired, the prototype dies can serve as the basis for development of production draw dies. With approval of the prototype parts, the production dies can then be built without delay or error—the true die conditions having been proved in the original, inexpensive prototype dies.

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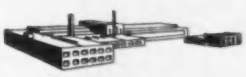
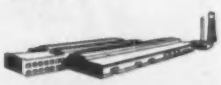


PLANT 2
Detroit, Mich.

PLANT 3
Hillsdale, Mich.



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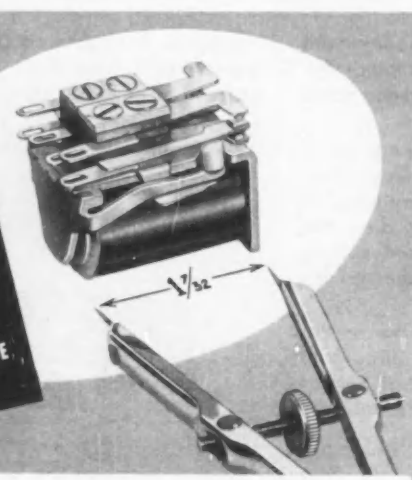

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position in the field of high energy nuclear accelerator construction which promises to be an area of great activity in the next few years.

In the past six years that we have been engaged in construction for Nuclear Research our biggest problems have been with the general suppliers. They feel that doing the work according to their best normal procedure is sufficient when, in fact, it still does not meet requirements.

We heartily agree that those versatile companies which have high caliber engineers teamed with skilled craftsmen will corner the major portion of the markets for the necessary high quality, high precision, and custom-tailored equipment. Dependability in performance is of prime importance in this very complex business of nuclear development.

—CHARLES F. VAN AMBER *and*
ROBERT M. MATYAS
Cornell University
Laboratory of Nuclear Studies

"Picturing the Brain Child"

To the Editor:

I have read and re-read your very fine editorial in the October issue of *Product Engineering*. May I say that I think most of your editorials are good and this one simply rates in my estimation as better. May I congratulate you. I propose to use the thought internally, twisting it a little bit as described in the under-lying needs of a salesman getting the idea across to his customer. For example, a color blind salesman is one who does not know his product.

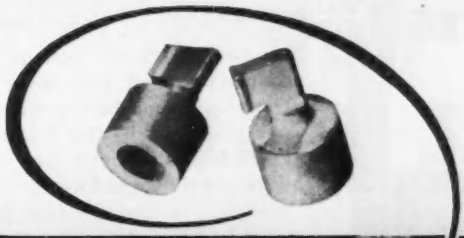
More broadly, it illustrates the need for educating people on whom our salesmen call and again reiterates the need, on our part and many people like us, of doing a better teaching job.

Many congratulations on the very excellent job. —P. A. ARNOLD
Reliance Electric & Engineering Co.

Reprints Wanted

To the Editor:

Would you please send us five or six copies of the article 'High Strength Steel For Aircraft Structures" appearing in the October issue of *Product*



Precision Casting Saves 33%

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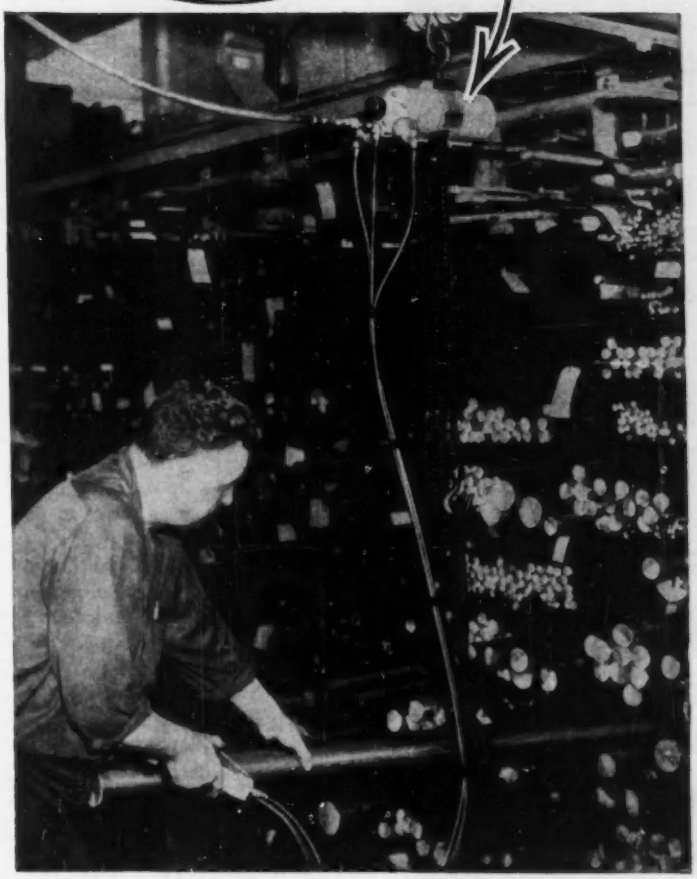

Control fingers for an air hoist are now precision-cast in one piece. Five machining operations are eliminated.

The control finger for this air hoist is stronger and costs one-third less now that it is a HAYNES precision investment casting. The fingers were formerly machined in two pieces and brazed together. The repeated strain of starting and reversing the hoist caused the parts to break at the brazed joint in two to six weeks. No breakage has occurred since changing over to the investment-cast parts.

Precision casting eliminates the brazing operation, because the fingers can be cast in one piece. In addition, several machining operations are no longer necessary—for a saving of 33 per cent.

For tips on designing parts to be produced by precision casting, as well as examples of successful applications, write for the booklet, "Investment Castings."

HAYNES TRADE-MARK *alloys*

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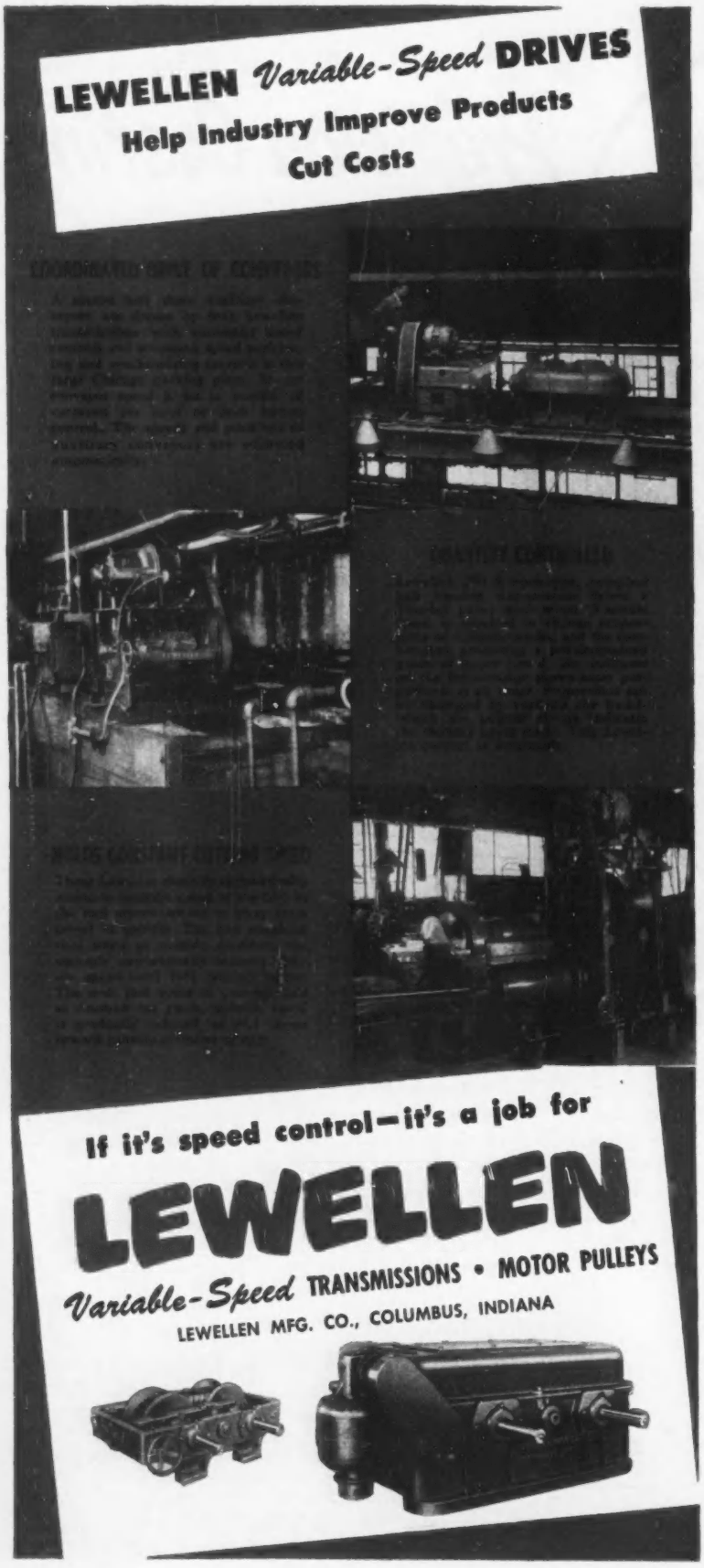

Engineering. We are about to enter into production of parts using high strength steels and believe this excellent article would be most helpful.

Your help in obtaining these copies will be greatly appreciated.

—J. A. JONES
Lockheed Aircraft Corporation

To the Editor:

I have just finished reading the article on the "Design of V-Belt Drive for Mass Produced Machines," and found the article to be very interesting and informative.

In my work I occasionally have use for V-Belts and would appreciate it if you would send me a copy of the form, "Two-Wheel V-Belt Drive Design Worksheet". —D. L. LUTEN
Chrysler Corporation

To the Editor:

We received our September copy and have found your article, "Design of V Belt Drives for Mass Produced Machines" and the accompanying worksheet, fill a need here at our College.

If it is possible, I would like to have a few (six, if it is not an imposition) copies of the entire worksheet.

Cogswell College is a two-year terminal engineering college on a practical level. Aids to design of this type are used to a large extent.

—WALTER D. HUGHES
Cogswell Polytechnical College

To the Editor:

We very much appreciated the recent contribution in the October issue of *Product Engineering* by J. M. Ramrath. If extra copies are available, we would be grateful to have three tearsheets of this article, "How Fast Does a Spring Expand?"

—C. R. LANDMANN
Diebold, Inc.

Logical Design Beginning

To the Editor:

The article appearing in *Product Engineering,* August 1953, page 170, entitled "Break-Even Charts" presents an interesting subject, in that it is one I have never seen explored before in technical literature other than that devoted to cost accounting.

Actually it is a subject basic to the design engineering field since the consideration of "break-even" is the essential first step in any design.—P. E.

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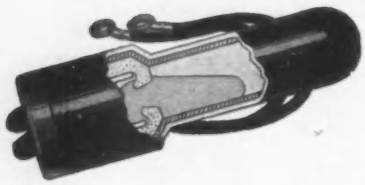

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Research Operations In Industry

Edited by DAVID HERTZ, *and* A. H. RUBENSTEIN, 6 x 8 *in.*, 453 *pp. Published by King's Crown Press, Columbia University, New York, N. Y.*, $8.50.

The material in this book includes all of the papers (and edited discussions of these papers) as presented at the Third Annual Conference on Industrial Research held at Columbia University in June 1952. In this sense, the volume is the Proceedings of the Third Conference. Actually it covers more than this. Included is the First Conference held in 1950 which emphasized costs, budgeting, and economics; the Second (1951) had as its theme the use, selection, and training of personnel in research. In 1952, the general topic was "Design for Research Operations."

The more than 30 papers and discussions of the three years embrace the broad fabric of all aspects of the research administrator's problems. Beginning with the Philosophy of Industrial Research, the sections include Economics, Costs, and Budgeting; Personnel in Industrial Research; Planning of Research Programs; Planning of Research Facilities; Research Methodology and Design of Experiment; Operations Research; and Communications and Technical Information Services.

Mechanical Vibrations

W. T. THOMSON, *Prof. of Engrg., University of California,* 6 x 9 *in.*, 252 *pp. Published by Prentice-Hall, Inc.*, 70 *Fifth Ave., New York* 11, *N. Y.*, $6.

Completely revised and up-to-date, this new edition provides an evenly-balanced treatment of the mechanics of the simple vibratory systems leading to equations of motion common to a variety of problems. Combining theory and practice, it is a blend of the theoretical basis, and practical "how-to-do-it" procedures.

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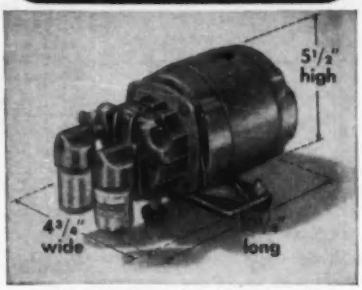

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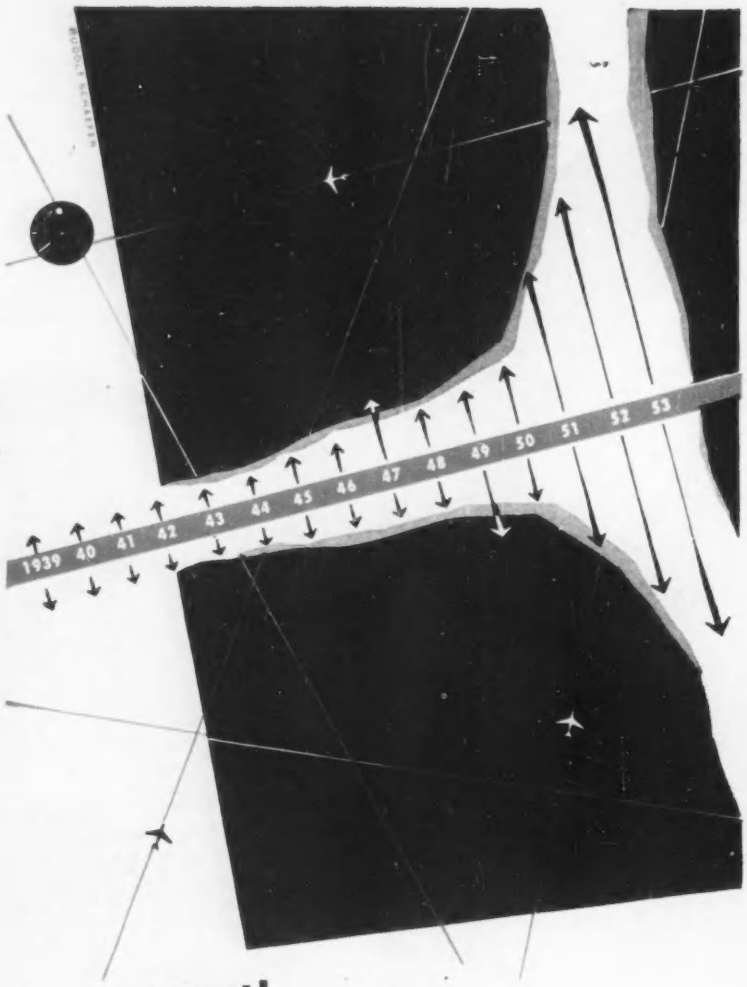

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tion for the understanding of them so that there is a practical preparation for the solution of any problem that may be encountered.

Although the book is designed for elementary use, there is a successful attempt to introduce, in a simple manner, methods suitable for solving the more advanced problems in the field. Thus, Raleigh's method, Stodola's iteration process, Holzer's analysis, the effective inertia method, Myklestad's tabular method, and Dunkerly's approximation are included. Many numerical examples are included to illustrate the methods of analysis.

Also covered are the vibration of elastic bodies, and the electromechanical analogy and the similarity principle as a practical approach to the evaluation of mechanical systems by experimental means.

Direct-Current Circuits

EARLE M. MORECOCK, *Head, Electrical Dept., Rochester Institute of Technology,* 6 x 9 *in.,* 388 *pp. Published by McGraw-Hill Book Co., Inc.,* 330 *West* 42 *St., New York* 36, *N. Y.,* $5.

This is the second edition of a textbook that is earmarked for use in technical institutes, junior colleges, industrial courses and home study. The first edition was published in 1944.

The material presented has been prepared to closely correlate classroom and laboratory study. Examples as well as problems to test the understanding of the principles involved have been inserted at frequent intervals. And the more comprehensive material is backed up with problems at the end of the chapters for review and additional practice.

Major changes from the first edition are the inclusion of the meter-kilogram-second system of units, a more pronounced emphasis on circuits and problems generally found in communication work and the revision of circuit drawings in accordance with the latest symbols recommended by the AIEE.

The material has also been rearranged to give a more orderly transition for the student from the basic concepts of the electron theory to those chapters on inductance and capacitance. Measuring instruments and introduction to magnetism and electromagnet-

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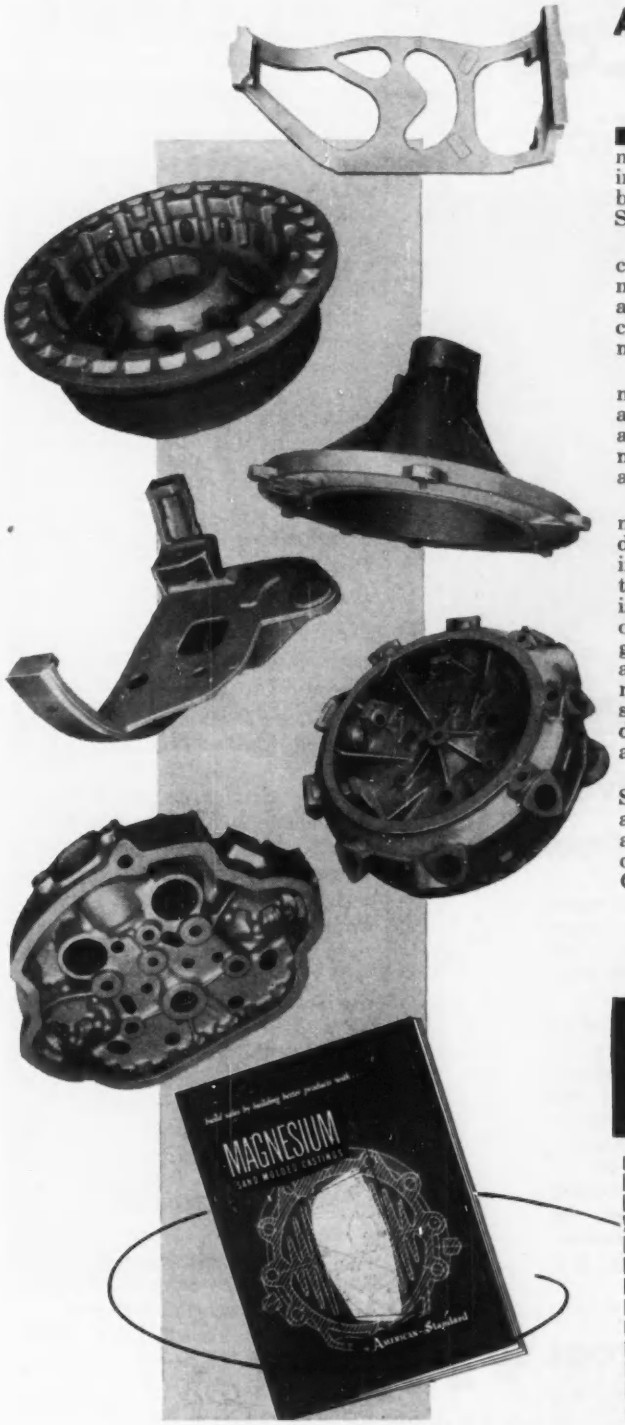

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ism come early in the text to give a basic background for the understanding of the more difficult subject matter.

The text is divided into 12 chapters and a series of appendices that contain standardized letter symbols and units, equation constants, and pertinent wire data. Material covered includes electrical concepts, wiring diagrams, magnetism and electromagnetism, measuring and instruments, power and energy, conduction and insulators, batteries, network circuits, magnetic circuits, electromagnetic induction and electrostatic and capacitance. Coverage of these subjects is based on the assumption that the student understands elementary algebra and plane geometry. It is also recommended by the author that college algebra and trigonometry be taught concurrently with this text.

Symposium on Plastics Testing—Present and Future

6 x 9 in., 76 pp. Published by American Society for Testing Materials, 1916 *Race St., Philadelphia* 3, *Pa.* $2.

Plastics development is moving ahead so fast that from time to time it is wise to pause and take stock of progress, to review the present state of development and to look ahead to the future. With this in mind, ASTM Committee D-20 on Plastics organized a Symposium on Plastics Testing—Present and Future which was presented at the Fifty-fifth Annual Meeting of the American Society for Testing Materials at New York in June 1952. The Symposium Committee, under the Co-chairmanship of H. K. Nason, Monsanto Chemical Co. and C. R. Stock, American Cyanamid Co., arranged an excellent group of papers which have been assembled for publication in one handy book.

The size titles are as follows: Introduction—C. R. Stock, American Cyanamid Co., Stamford, Conn.; The Measurement and Significance of the Mechanical Strength Properties of Plastics—J. P. Tordella, A. C. Webber, and E. B. Cooper, E. I. du Pont de Nemours and Co., Wilmington, Del.; Measurement of Color, Gloss and Haze—Harry K. Hammond III, National Bureau of Standards, Washington, D. C. and George W. Ingle, Monsanto Chemical Co., Springfield,

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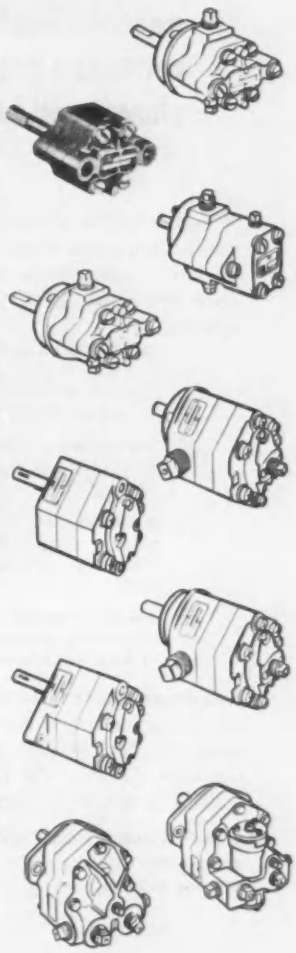

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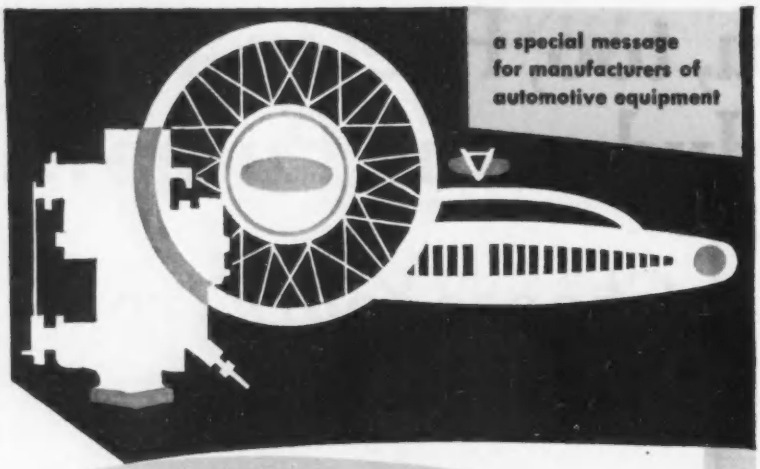

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Mass.; The Effects of Molding Conditions Upon the Permanence of Plastics—J. L. Williams and J. W. Mighton, the Dow Chemical Co., Midland, Mich.; Residual Stresses in Phenolic Plastics—L. E. Welch, Glen Ridge, N. J. and H. M. Quackenbos, Jr., Bound Brook, N. J.

Kinematics of Machines

ROLLAND T. HURKLE, *Prof. of Mechanical Engineering, Michigan State College. 6 x 9 in., 231 pp. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York* 11, *N. Y.* $4.75.

Written at the level of the undergraduate engineering student, this book emphasizes the relative motions of machine parts and mechanisms rather than the descriptions of these mechanisms. It presupposes a knowledge of engineering mechanics and a working knowledge of calculus.

Terminology and the fundamentals of motion are presented in the first chapter. This is followed by additional theory, and applications to specific mechanisms. Considerable attention is devoted to the fundamentals and application of relative velocity techniques and velocity polygons. Graphical methods for determining accelerations are also presented as well as the conventional analytical approach.

Also included are chapters on Cams, Rolling Contact, Gearings, and Flexible Connections.

Electricity and Magnetism

EDSON RUTHER PECK, *Assoc. Professor of Physics, Northwestern University. 6 x 9 in., 476 pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York* 36, *N. Y.* $7.50.

This work is designed for the advanced undergraduate level, assuming a background in physics and elementary calculus and using simple vector notation with more advanced mathematics introduced as needed. Primarily theoretical, the book maintains contact with the laboratory by numerous practical problems.

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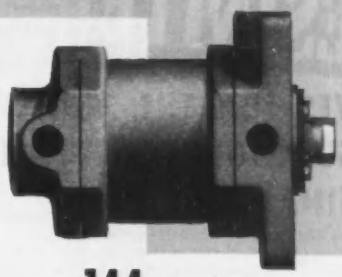

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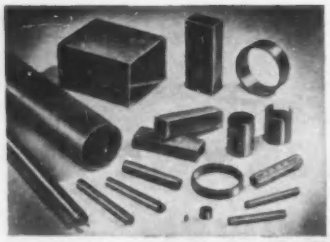

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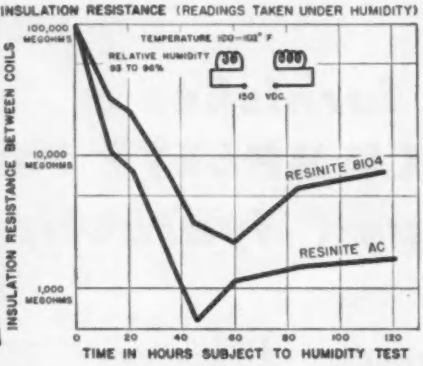

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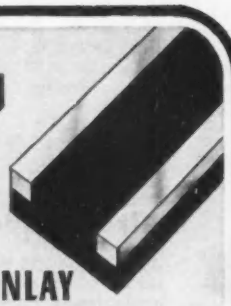

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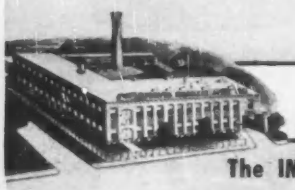

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Protective Atmospheres

A. G. HOTCHKISS, H. M. WEBBER, *Industrial Heating Dept., General Electric Company.* 6 x 9 *in.*, 341 *pp. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.* $7.

Protective atmospheres are saving money, improving quality, and speeding production in industry. This book is designed not only to give process engineers, plant engineers, and metallurgists a usable understanding of the various phases of these protective atmospheres, but also to help them select the best atmosphere gases for given jobs and apply them profitably.

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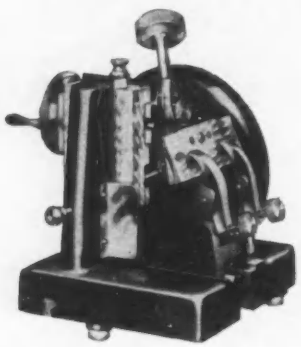
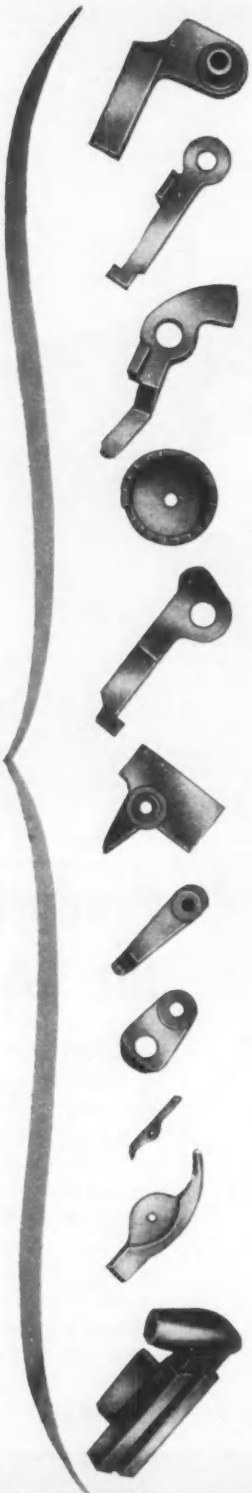


International Equipment Co., Boston, Mass., manufactures the Microtome shown and other precision instruments. For the Microtome, they chose Hitchiner precision investment stainless steel castings because they could get extremely accurate parts with a minimum of machining. These castings also lend themselves to the very high, bright, smooth finish necessary on instruments of this quality.

Whatever your requirements may be in small castings, we will be happy to have you utilize our facilities and experience in solving your parts problems. Quotations furnished promptly on receipt of your prints.

Hitchiner castings finished to print are available through an associate company.



HITCHINER Manufacturing Company, Inc.
MILFORD 4, NEW HAMPSHIRE
Representatives in principal cities.

ing decarburization, for carburizing, carbon restoration, and nitriding; instruments for analyzing controlling, and measuring gases; and gas storage, distribution, and handling.

Of special note is a chapter devoted to protective atmosphere ailments and their remedies, in which simple tests are given to determine the causes and results of discoloration, oxidation, or decarburization. In this volume, no attempt has been made to cover all types of gases available for particular jobs or all conceivable applications for any one gas. It considers only those gases most commonly used at present in the United States.

Information Theory

STANFORD GOLDMAN, *Professor of Electrical Engineering, Syracuse Univ.* 6 x 9 *in.*, 385 *pp. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York* 11, *N. Y.* $9.

The prime purpose of this work is to present a thorough discussion of the principles of information theory. The presentation is based on the pioneering and classical work of C. E. Shannon and, to a lesser extent, on the earlier work of Norbert Wiener. The author aims to carry out the foregoing and still retain a mathematical level within the scope of undergraduate students in electrical engineering.

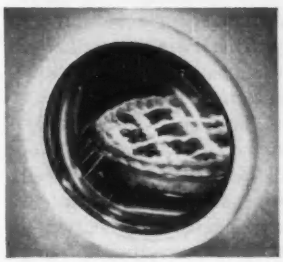
The chapter headings are as follows: Information Theory of Discreet Systems; Some Properties of Continuous Signals; Ergodic Ensembles and Random Noise; The Entropy of Continuous Distributions; The Transmission of Information in Band-Limited Systems Having a Continuous Range of Values; Information Theory Aspects of Modulation and Noise Reduction; Linear Correlation, Filtering, and Prediction; Various Aspects of Information Theory; and Appendices.

Metallurgical Dictionary

J. G. HENDERSON, *Consulting Engineer and* J. M. BATES, *University of Illinois.* 6 x 9 *in.*, 396 *pp. Published by Reinhold Publishing Co.*, 330 *W. 42nd St., New York* 36, *N. Y.* $8.50.

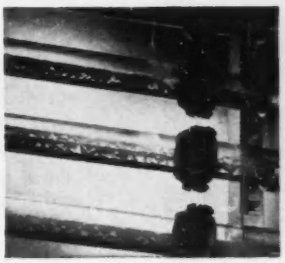
Arranged specifically for the needs of all metal industries, this reference book contains over 5,000 informative definitions and descriptions covering

8 properties of glass to help you make better products



1 Transparency

You can let customers see inside your product through glass. A good example is the PYREX brand oven window that *stays* crystal clear.

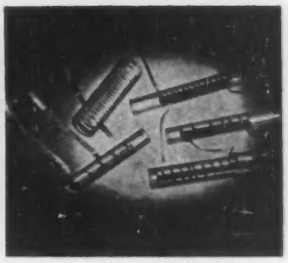


2 Corrosion Resistance

If your product must cope with corrosive liquids or atmospheres, glass will improve its operation, lengthen its life. It's the world's most corrosion-resistant material. The severe service PYREX brand pipe stands in chemical plants illustrates the point.

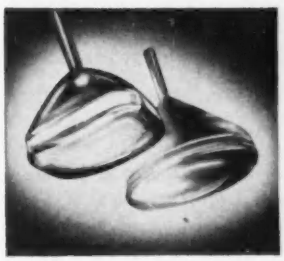
3 Heat Resistant

Don't rule out glass where your problem is heat, or quick switches from hot to cold. PYREX brand glass No. 7740 will stand temperatures from below zero to 250° F., while VYCOR brand glass goes up to 1800° F.



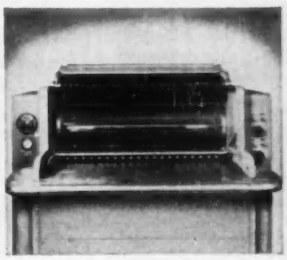
4 Electrical Stability

Glass components may provide such properties as low power factor, low temperature coefficient of capacitance and inductance.



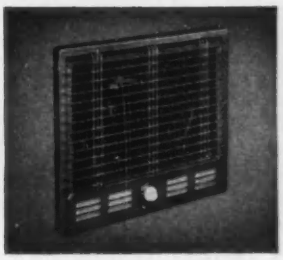
5 Hermetic Enclosure

Glass forms perfect glass-to-glass or glass-to-metal seals for vacuum-tight applications. Vacuum bottles are a good example. So are TV tubes and sealed beam headlights.



6 Light Transmission

Glass can accurately control and transmit light with permanent reliability. Good examples are all around you but one rather unusual one is the glass cylinder in this printing machine. It transmits the ultraviolet rays produced by a mercury arc lamp.



7 Heat Generation

Although you normally think of glass as an electrical insulator, Corning's E-C glass conducts electricity and radiates heat. E-C glass is ideal for space heaters, dryers, and other applications especially where an *even* heat distribution is wanted.

8 Photosensitivity

Designs reproduced photographically in Corning's special photosensitive glass cannot fade or wear off. They are ideal for permanently reproducing nameplates, photographs, artwork and offer a variety of design possibilities.

These eight properties give you only an indication of the versatility of glass by Corning.

This remarkable material can be made extra strong or weak, to conduct electricity or act as an insulator, to pass light or cut it off in virtually any size, shape or color you need.

It may pay you well, in terms of better operating characteristics, lower production costs, and extra sales points for your product, to consult Corning engineers before you reach the blueprint stage. For further information, just mail the coupon or write for a copy of, *"GLASS—its increasing importance in product design."*

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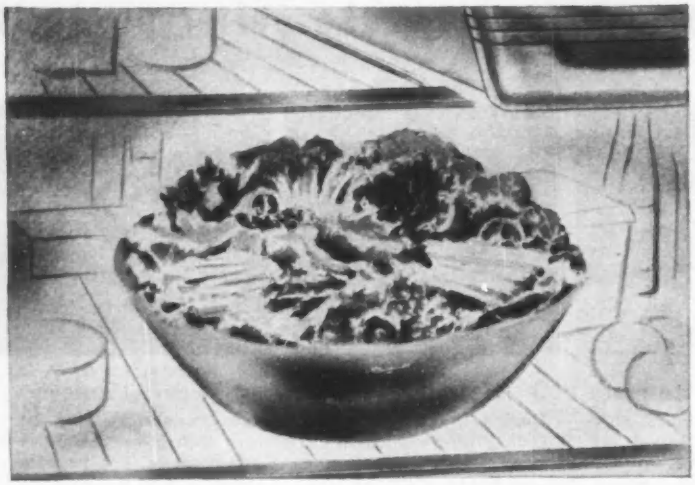
City..... Zone..... State.....



How Beryllium Copper Springs keep foods fresher...longer

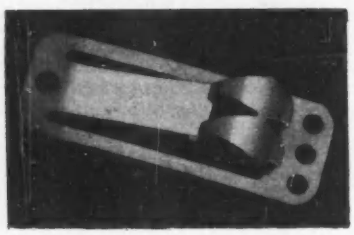
A BERYLLIUM COPPER SPRING is the "memory cell" of the defrosting mechanism of a leading household refrigerator. This small flat spring completely eliminates the necessity for remembering to defrost at the proper intervals. Thus, this beryllium copper spring functions in the defrosting timing cycle of the refrigerator — and through this increased efficiency, it helps keep foods fresher . . . longer.

The design engineers set rigid specifications for this defroster-actuating spring. They wanted, above all, maximum dependability and long life. The production department insisted on early and frequent deliveries after design details had been settled . . . and they wanted them in large quantities. And, naturally, the purchasing office demanded lower unit costs!

There's nothing too exceptional about these specifications. But there *is*, we believe, an unusual story in the manner in which they were exceeded—*on every count!*

I-S Micro-Processed Springs of Beryllium Copper

were chosen and are still being used for this installation because of their 4-way superiority:



You have the identical basic problems—time and unit costs, plus product performance. We feel that this particular spring application, clearly demonstrates two important Instrument Specialty features: *(1) our ability to produce a better spring, faster and usually at lower cost to you. (2) the specialized ability of our engineers to cooperate with your designers in meeting practically any exceptional problem that involves spring-making.*

It cost you nothing to compare methods and costs.

(*1*) HIGHER DEGREE OF UNIFORMITY AND dependability than conventionally-made springs.

(*2*) I-S DESIGN ENGINEERS' SPECIALIZED experience in spring-making, aided in redesigning for our exclusive "strip spring" technique which permits hardening in multiple fixtures to assure the uniform dimensional and elastic performance. This also resulted in substantial unit-cost reduction.

(*3*) THIS SAME I-S EXCLUSIVE STRIP DESIGN showed further savings in subsequent assembly-line operations—such as cleaning, inspection and attaching of the silver contacts and elimination of costly hand adjustments.

(*4*) ONLY I-S EXCLUSIVE TECHNIQUES, methods and patented equipment could have produced these far superior springs within the time limits set by the production department.

Instrument Specialties Co. Inc.
234-E BERGEN BOULEVARD, LITTLE FALLS, NEW JERSEY
Telephone Little Falls 4-0200

For full information on I-S Micro-processed Springs, write today for your free copy of Catalog 7; for Electronic Components, ask for Catalog No. 7-A.

inputs. These chapters constitute the normal course in automatic control systems. Chapters 12 through 15 discuss further techniques and tools that the designer uses, namely, numerical integration, automatic computers, methods for analyzing transient response data, and nonlinear systems. Automatic computers have become an essential tool for control system design, and Chapter 13 serves to introduce to the reader their methods of operation. Chapter 14 discusses methods for analyzing transient response data. This chapter is intended to aid those who want to write an equation fitting a given transient. Chapter 15 is a brief introductory chapter on nonlinear system, and is aimed at challenging the reader to explore this field further. The appendix includes reference material often used in control analysis work. Particular appendix features are design data for cascaded compensating functions and a table of Laplace transform pairs.

Design for Decision

IRWIN D. J. BROSS, *Statistical Consultant, Cornell University Medical College. 6 x 9 in., 276 pp. Published by the MacMillan Co., 60 Fifth Ave., New York 11, N. Y.* $4.25.

In plain, understandable English, the author tells the meaning of Statistical Decision and explains the scientific method for making decisions in common sense terms without high-powered mathematics or algebraic details. He gives practical answers to such questions as: What are the methods for predicting the future? How can the reliability of information be judged? Are there any values in science? How can the methods used in scientific laboratories be applied to community planning, labor relations, politics, or business decisions?

The author explains a variety of potent statistical tools which have already been used in the scientific laboratory. The author trys to bring these methods out of the laboratory, and with many illustrations from experience, show the reader how he can use them.

The author uses everyday language, but warns the reader that there will be no blueprints to permit him to construct his own decision-maker. Such blueprints will only be given in sym-

all the most essential terms in both production and physical metallurgy.

Semi-encyclopedic in nature, it has been limited in scope so as not to encumber the user with obsolete or widely remote material. Its sole purpose is to provide a comprehensive, easy-to-use, thoroughly up to date working tool for all those who manufacture or use metals and metal products. Original definitions are included of a sizable number of terms, such as flame plating, shell molding, and others that have only very recently appeared in magazine literature.

Particular care has been taken to cross-reference entries of related terms. This has been done not only to facilitate reference to compound terms, but also to direct the user from a synonym to a preferred term and to offer him a full coverage of available information.

Principles of Automatic Control

FLOYD E. NIXON, *The Glen L. Martin Co.* 6 x 9 *in.*, 407 *pp. Published by Prentice-Hall Inc.*, 70 *Fifth Ave., New York* 11, *N. Y.* $9.35.

The aim of this book is to give the reader a reasonably complete understanding of the various principles utilized in the design of an automatic control system. Simple control systems can be defined by mathematical equations whose solutions are relatively simple. However, more complicated systems involve highly complicated, interacting equations whose solutions are very difficult by conventional methods.

Therefore, the author discusses all aspects of linear system design and covers transient response, frequency response, stability criteria, numerical integration, automatic computers and transient analysis. His book is intended as a reference, self-study, or undergraduate level text. Accordingly, except for the appendix on the derivation of the Nyquist criterion, no mathematical background beyond first-year calculus should be required for any of the material. A first-year course in physics is assumed, and a course in electrical circuits would be helpful, but is not essential.

Chapters 1 through 11 discuss frequency and transient response methods, as well as stability criteria, proper gain adjustment, compensating methods, and the effect of noise and extraneous

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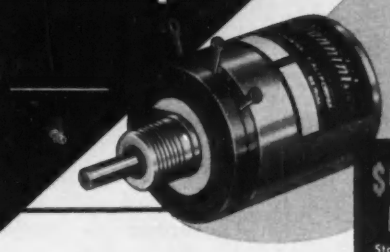

New design and advanced production techniques enable Giannini to bring you the advanced Minitorque* potentiometer at a NEW LOW PRICE. Here, from the leader in low torque potentiometer design and production, is a rugged, high accuracy unit, at half the price of comparable potentiometers.

The Minitorque* is a low torque Instrument Quality potentiometer 1" in diameter, with a stainless steel shaft and oilite sleeve bearing. Standard models with resolution from 0.06% to 0.19%, and linearities of ±0.5% are now *available for immediate delivery from stock.* The Minitorque* is especially adaptable to laboratory test equipment, computer systems, remote telemetering, and process control, where a dependable, lightweight potentiometer is required.

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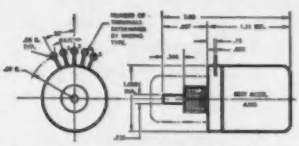

STOCK MODEL SPECIFICATIONS**

LINEARITY: ±0.5% of total resistance, or better.
TORQUE: Starting: 0.025 oz. in.
SHAFT ROTATION: 360°.
WINDING ANGLE: 354° Minimum. (A minimum gap is provided so that brush will not short winding in region of 354° to 360°.)
TEMPERATURE COEFFICIENT: .00006 ohms/-ohm/°C max.
TEMPERATURE RATING: Operating range from −54° to +71°C.
ACCELERATION: Will function during acceleration of 50 G's applied along any axis.
VIBRATION: Will function during vibration of 0.060 in. total excursion, at frequencies varying from 10 to 55 cps applied along any axis.
VOLTAGE BREAKDOWN: Will withstand 500 v AC (rms) at 60 cps, between any terminal and shaft at sea level.
WEIGHT: 0.6 oz.

*Reg. U. S. Patent Office

These resistance values in stock for immediate shipment:

500 ohms	2K ohms	10K ohms	50K ohms
5K ohms	5K ohms	20K ohms	100K ohms

**There are twelve wiring types available, in addition to special modifications to customer's requirements.

Resistance (ohms ±5%)	Maximum Current (ma at +25°C)	Average Total Turns
100	117	525
250	81	615
500	56	760
1,000	39	770
2,000	29	1,020
5,000	20	1,190
10,000	14	1,400
20,000	8.6	1,660
50,000	5.5	1,660
100,000	3.9	1,660

TYPE 9

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For complete information, write for Minitorque Bulletin No. 111.*

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CPI PLUGSTATS provide precise thermal warning without calibration drift. Small physical size has been combined with rugged construction. Special alloy contacts assure clean make-and-break. Capable of 200°F overshoot from high or low normal setting. Available also with AN connector. Rated at ¼ ampere, 28 volts, AC or DC resistive loads. Contacts NO or NC. Weight approx. 1.5 oz.

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bolic language. The author attempts to describe the decision-maker, and to explain some of the principles on which it operates. For these purposes the machine will be taken apart, and each part studied separately. After reassembling, its operation in some simple situations will be described.

Industrial Uses of Radioactive Fission Products

8 x 11 *in.*, 102 *pp. Available from Project* 361, *Stanford Research Institute, Stanford, Calif.*, $1.50.

Available again after having been out of print for six months due to an unexpectedly large demand, this is a study conducted by the Stanford Research Institute under contract to the AEC from September 1950 through August 1951.

On the basis of a field survey and correspondence, the preliminary suggestions for specific industrial uses are evaluated. Also, information in this report should help give an understanding of the nature and magnitude of the problem that must be overcome if large-scale industrial use of fission products is to become a reality. Some typical questions identified and considered are:

Should fission products be made available to industry? When?

What policy should be followed in pricing fission products?

Upon what unit of measure should the sale of fission products be based?

What degree of separation and refinement of fission products should be accomplished by the Commission?

Will industry find it profitable to investigate this new field?

How should the Commission's education program be expanded?

How can the Commission's experience in the use of radiation be communicated to industry?

What can be done to standardize safety procedures?

Who should distribute fission products to industry?

What engineering services should be supplied by the distributor of fission products?

Can a central waste disposal authority and facility be established?

What research and development programs should be established by the Commission?

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SuVeneer Clad Metal gives you actual copper or brass bonded inseparably to a strip steel core. The surface is solid, rolled metal—not a porous plating or coating.

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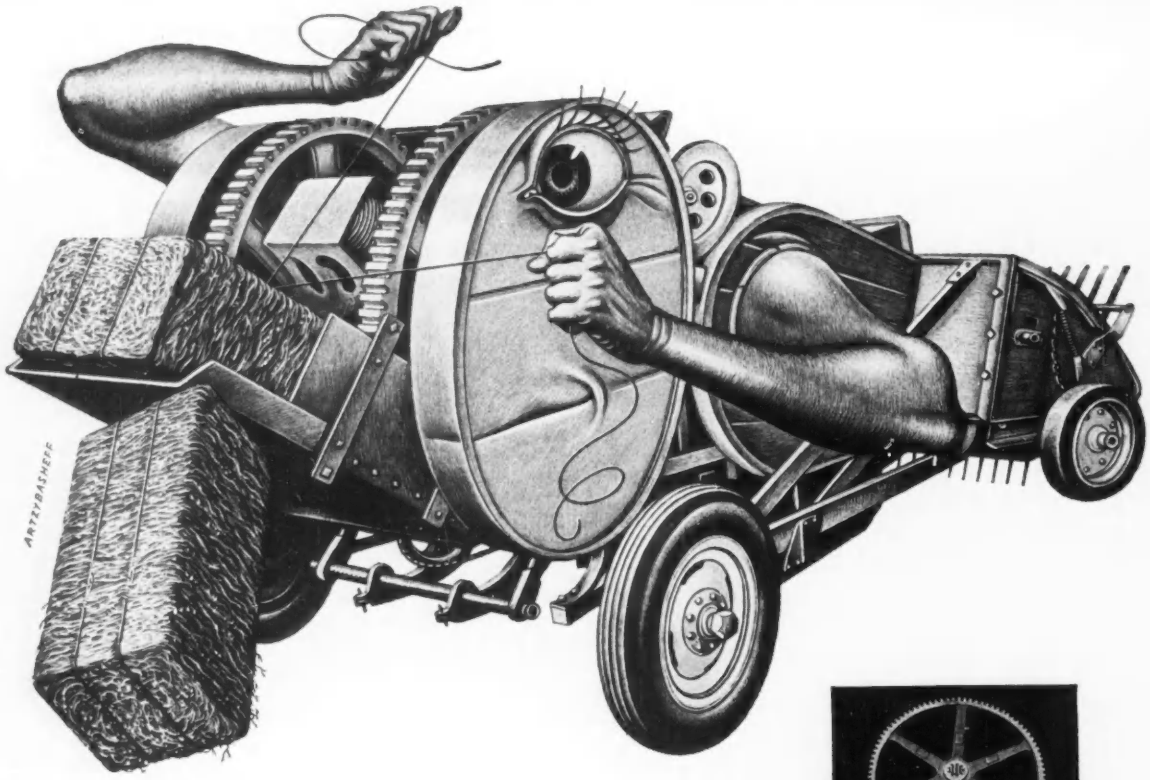

Strong "wrists" for America's new hay balers

Whisking through fields of hay . . . picking up and handling an almost incredible 2,500 bales per day . . . this man-saving, time-saving, money-saving NEW IDEA hay baler needs mighty tough gears to keep its tying mechanism on the job. To be certain these steel "wrists" have maximum strength and durability . . . NEW IDEA looks to Lycoming.

Do *you* need a precision part . . . volume production of a metal product . . . a dependable air-cooled engine . . . or development of "just an idea" in the rough or blueprint stage? Then remember—many of America's industrial and military leaders credit Lycoming with solving their most complex metal-working problems. Whatever your problem . . . *look to Lycoming!*

More than 6,000 machine tools, a wealth of creative engineering ability, and 2½ million square feet of floor space stand ready to serve your needs when you look to Lycoming.

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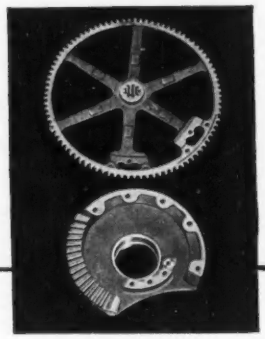


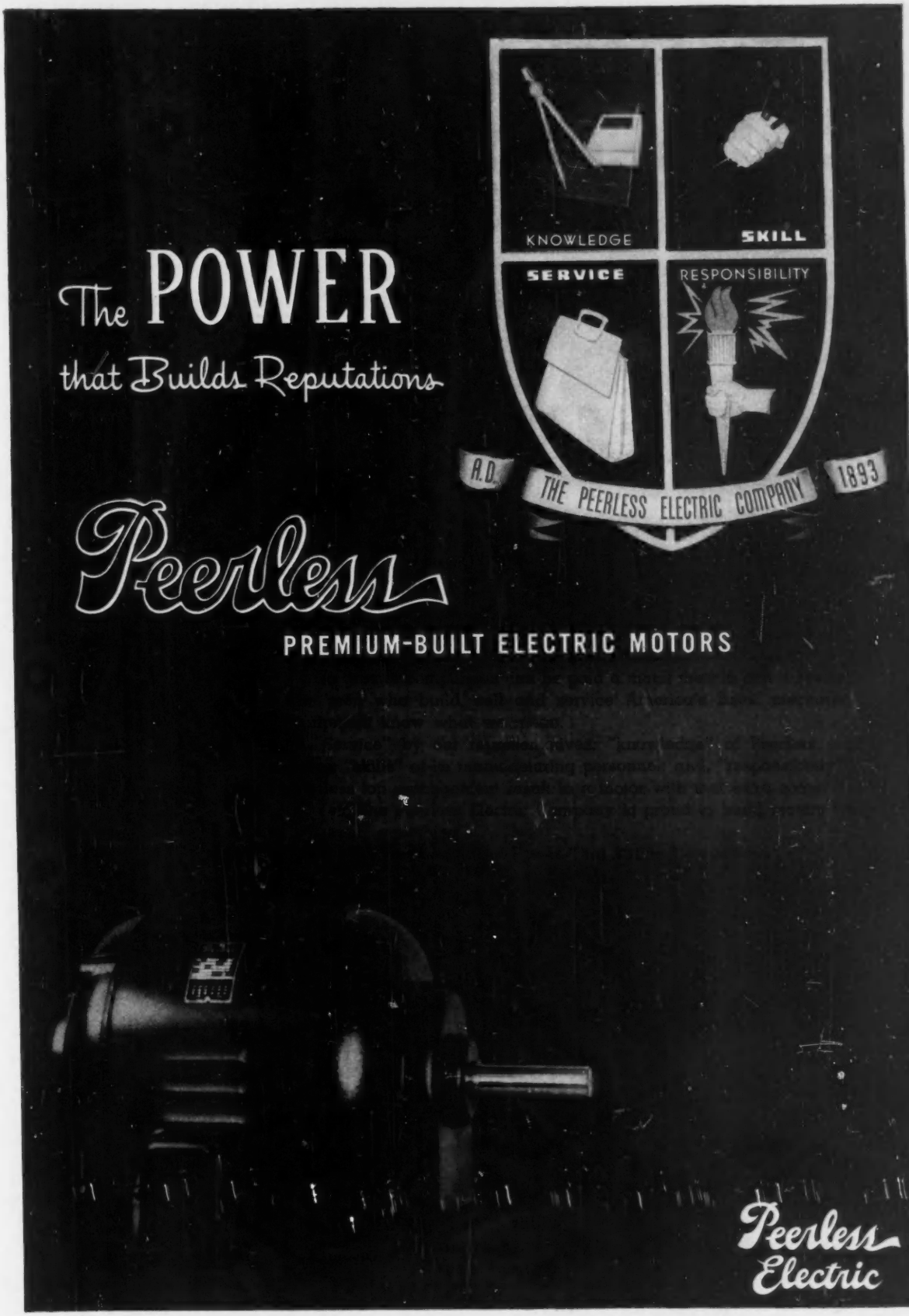
For sturdy, unfailing spur and bevel gears—"wrists" that drive the tying mechanism of its "one-man" hay baler—NEW IDEA looks to Lycoming for precision production.

For a more complete story on Lycoming's varied abilities and facilities, write—on your company letterhead—for the illustrated booklet, "Let's Look at Lycoming."

FOR RESEARCH • FOR PRECISION PRODUCTION

LOOK TO **LYCOMING**

Lycoming-Spencer Division, Williamsport, Pa. AVCO MANUFACTURING CORPORATION Bridgeport-Lycoming Division, Stratford, Conn.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now Firestone service pictures your processing needs

based on the high processing speed and wide versatility of

905 — 915 — 925 EXON

With Firestone service, you can chart many a processing problem to a quick solution.

At right for example, you can see on Firestone's 3-dimensional chart why your operating temperature need never hinder your ingenuity or product progress.

For any given plasticizer loading, use this chart to determine the proper ratio of EXON resins for *your* operating conditions.

It was to serve you in solving many of your production problems that Firestone created the three new, fast-fusing polyvinyl chloride resins, EXON 905, 915, 925. These temperature-tailored resins offer several unique advantages. Among them are:

- **Extremely rapid blending...hot or cold.**
- **Shorter fusing time...for a faster, more economical operation.**
- **Freedom from fisheyes...assuring higher quality, greater product uniformity.**

When you come up against a processing problem, team Firestone service with Firestone's versatile resins...and let them help you open new horizons for your equipment.

PHYSICAL PROPERTIES

	FORM	SPECIFIC GRAVITY	AVERAGE RELATIVE VISCOSITY	AVERAGE BULKING DENSITY
EXON 905 Excellent for film and sheeting applications where higher temperatures (up to 375° F.) are called for.	White Powder	1.40	2.50	0.45
EXON 915 High-versatility, resin specially designed for sheeting. Wide range of operating temperatures.	White Powder	1.40	2.30	0.45
EXON 925 An excellent P. V. C. resin for low processing temperatures. (starting at 275° F.)	White Powder	1.40	2.05	0.45

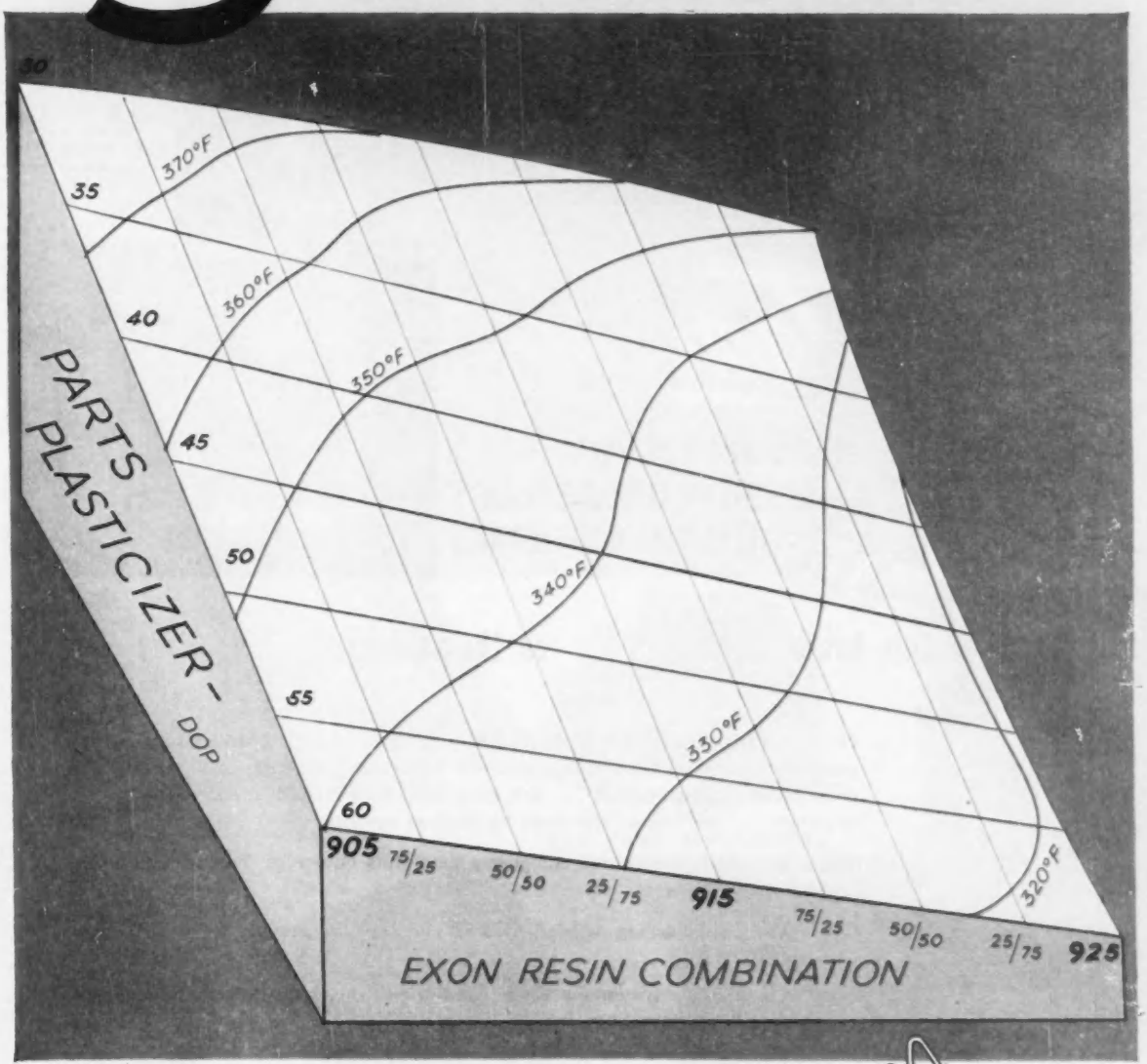
For further information on Firestone's complete line of high quality EXON resins...or for the assistance of Firestone's Technical Service, call or write:

CHEMICAL SALES DIVISION

FIRESTONE PLASTICS COMPANY • POTTSTOWN, PA., DEPT. 19P

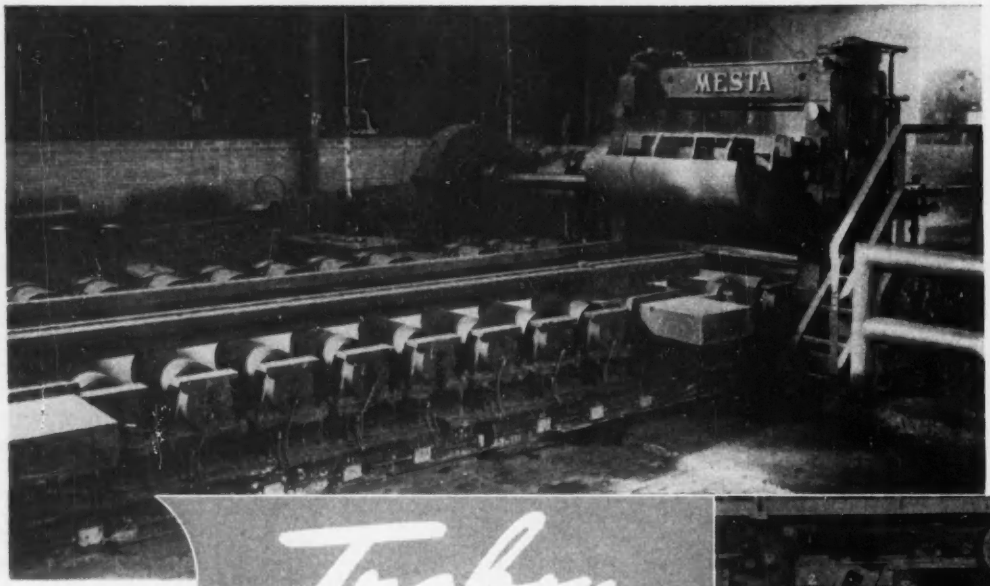
Division of Firestone Tire and Rubber Co.

...in 3 dimensions!



IN ORDER to determine quickly and easily the proper combination of EXON resins best suited to *your* processing conditions, just consult the handy chart above.

Follow the black line indicating Parts Plasticizer to the intersection of your Operating Temperature indicated by the red line. Carry this point parallel to the green guide lines down to the EXON Resin Combination at the bottom of the graph.

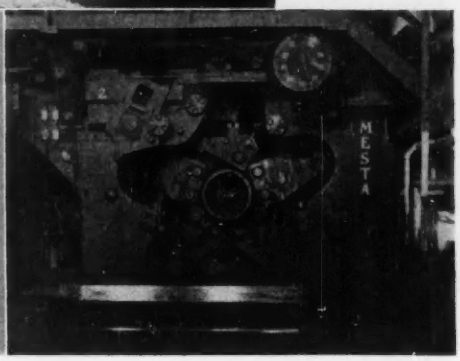


260-point, newly designed, run-out table at Allegheny Ludlum, automatically lubricated by Trabon.

11 bearings on the revolving mandrel of this Allegheny Ludlum coiler are quickly and easily lubricated by Trabon.

Trabon

LUBRICATES 3800 BEARING POINTS AT ALLEGHENY LUDLUM PLANTS IN PITTSBURGH DISTRICT



this has a BEARING on the subject

Here at one of the country's leading steel companies is a good example of dependable, versatile TRABON automatic lubrication at work. 3800 points on a wide variety of equipment . . . hot strip mill, cold tandem mills, soaking pits, furnaces . . . are being lubricated by Trabon systems.

There are good reasons for Allegheny Ludlum's choice of Trabon automatic lubrication systems:

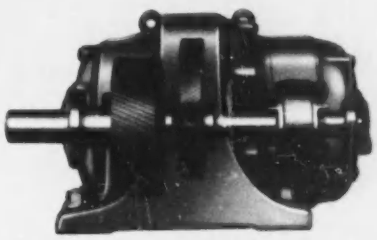
- Trabon engineering service assures the best in design, fabrication and installation.
- It's a *positive* system—a single indicator at the pump to tell the operator when all bearings have been lubricated.
- It's completely sealed so that it operates effectively even underground and is unaffected by steam, dirt or snow.
- Trabon systems, for either oil or grease, fit any bearing situation.

Write for more information today.

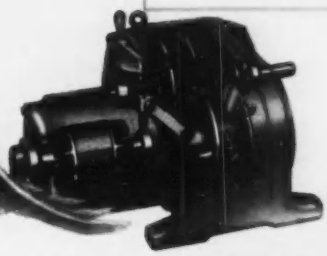
Trabon ENGINEERING CORPORATION
1814 E. 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems

POWER

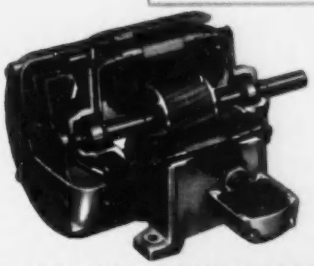
at the top level of dependability



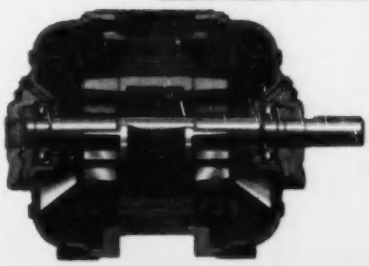
U. S. SYNCROGEAR MOTOR



U. S. VARIDRIVE MOTOR



U. S. TOTALLY-ENCLOSED MOTOR



U. S. UNICLOSED MOTOR

US MOTORS

THEY'VE MADE THEIR WAY BY THE WAY THEY'RE MADE

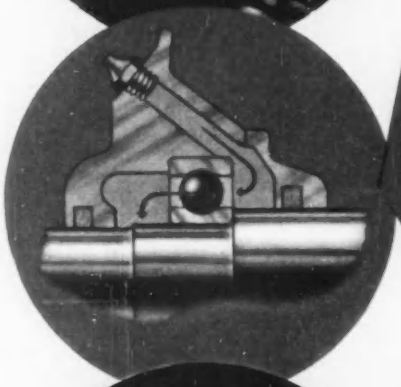
EXTRA FEATURES in U. S. MOTORS increase dependability

If extra long motor life interests you, look into U. S. Motors. Three major features give U. S. Motors years of extra life. (1) All windings are asbestos-protected because asbestos can never carbonize. The windings are forever safe against high temperatures. (2) Lubriflush lubrication insures bearing life far in excess of endurance of conventional types. You get life-time lubrication plus the convenience and durability of re-lubrication. (3) All castings are normalized to maintain accuracy of bearing settings.

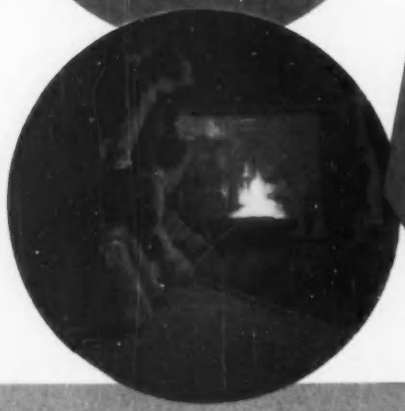
Added features include centricast rotor, advanced styling, weatherproof design, highly hardened gears in Syncrogear types, and extra quiet operation. All add up to extreme dependability, unequalled in any other motors.

Extra life without extra cost

ASBESTOS PROTECTION



LUBRIFLUSH BEARINGS



NORMALIZED CASTINGS

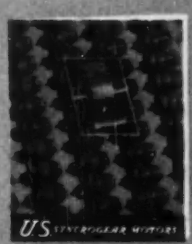
ANY OF THESE INFORMATIVE MOTOR BULLETINS — FREE FOR THE ASKING

UNICLOSED
Most attractive of all motors. Weatherproof. Drip-proof. Streamlined. Capacities to 250 h.p.

VARIDRIVE
Thousands of speeds by simple dial control. 2 to 10,000 r.p.m. Increases output. Quickly repays investment.

ALL U. S. MOTORS
A condensed catalog featuring all types of U. S. Motors in full color. Presents 19 types of motors.

EXPLOSION-PROOF
Totally-enclosed types meeting Underwriters' specifications. Latest improvements for hazardous service.



SYNCROGEAR
Internally-geared motors up to 20 h.p. Pyramidal design. Hardened gears. Sealed protection. 10 to 10,000 r.p.m.

SANITARY
Advanced design meeting all sanitary requirements. Immaculate. Baked white enamel finish. Rustproof.

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Send U.S. Motors Bulletin as checked below:

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U. S. ELECTRICAL MOTORS, INC.

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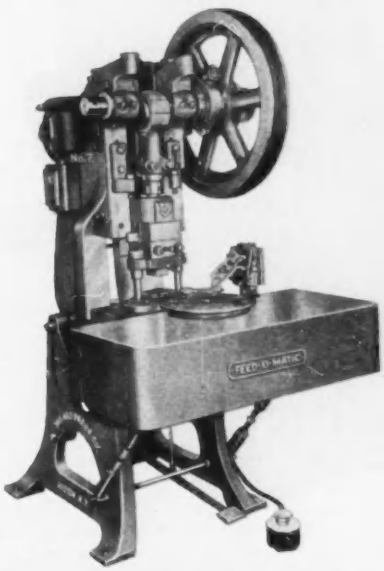
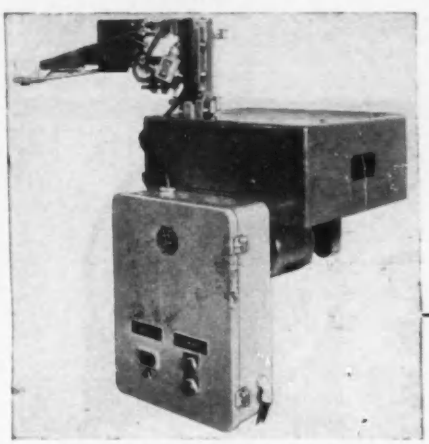
Sales offices in all principal cities. Consult Phone Directory

When reaching into a dangerous place your hand might make an error. The Feed-O-Matic will not.

the way your hand and arm would move



The Feed-O-Matic can match the rhythm of a punch press or of any machine that has rhythm.



The Feed-O-Matic is adaptable. For example, nests can be multiple or single in accordance with the sizes and types of parts to be handled.

If you had to lift a small article and place it accurately in the correct position, and had to be alert against letting a machine operate if the placing was not completely right, and you had to repeat that operation with rhythmic precision all day and perhaps all night, then your hand and arm would move exactly the way the arm of the V & O Feed-O-Matic moves.

You would not work with the invariable precision of the Feed-O-Matic, of course. Nothing human could do that. You would make dangerous mistakes that the Feed-O-Matic never makes when you reach into dangerous places. You would let your attention wander and would forget, as the Feed-O-Matic cannot forget, to prevent the machine from acting if you mis-positioned a part. But as long as you managed to keep going your hand and arm would use the same motions that the Feed-O-Matic uses.

This "natural" rhythmic motion makes the Feed-O-Matic easy to understand and apply. It governs the operating rhythm of a punch press and can govern any similar machines. It can supply its own rhythm to space objects evenly along a conveyor belt or other materials handling device.

You can make the feeding of dangerous machines completely safe. You can use high cost tools that you never would dare to expose to human fallibility.

Your plant has plenty of uses for Feed-O-Matics. The full story is yours for the asking. An engineer who can tell you all about it is right in your neighborhood. Write us.

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THE V&O PRESS COMPANY

DIVISION OF EMHART MFG. CO.

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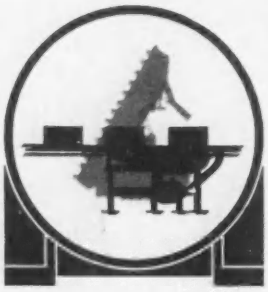
Builders of Precision Power Presses and Feeds Since 1889



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When space is a problem, specify Fairbanks-Morse Axial Air Gap Motors.

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for every industry

When you need electric motors . . . in any rating, or frame type . . . one or a thousand . . . *always* look for the Fairbanks-Morse Seal. For over 120 years it has stood for the finest in manufacturing integrity to *all* industry.

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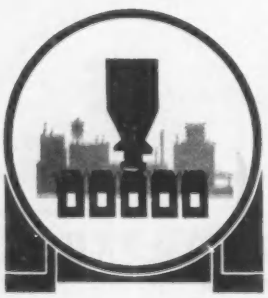
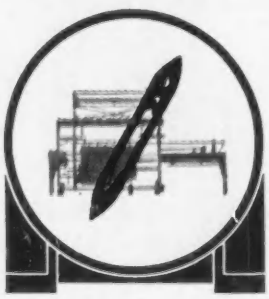
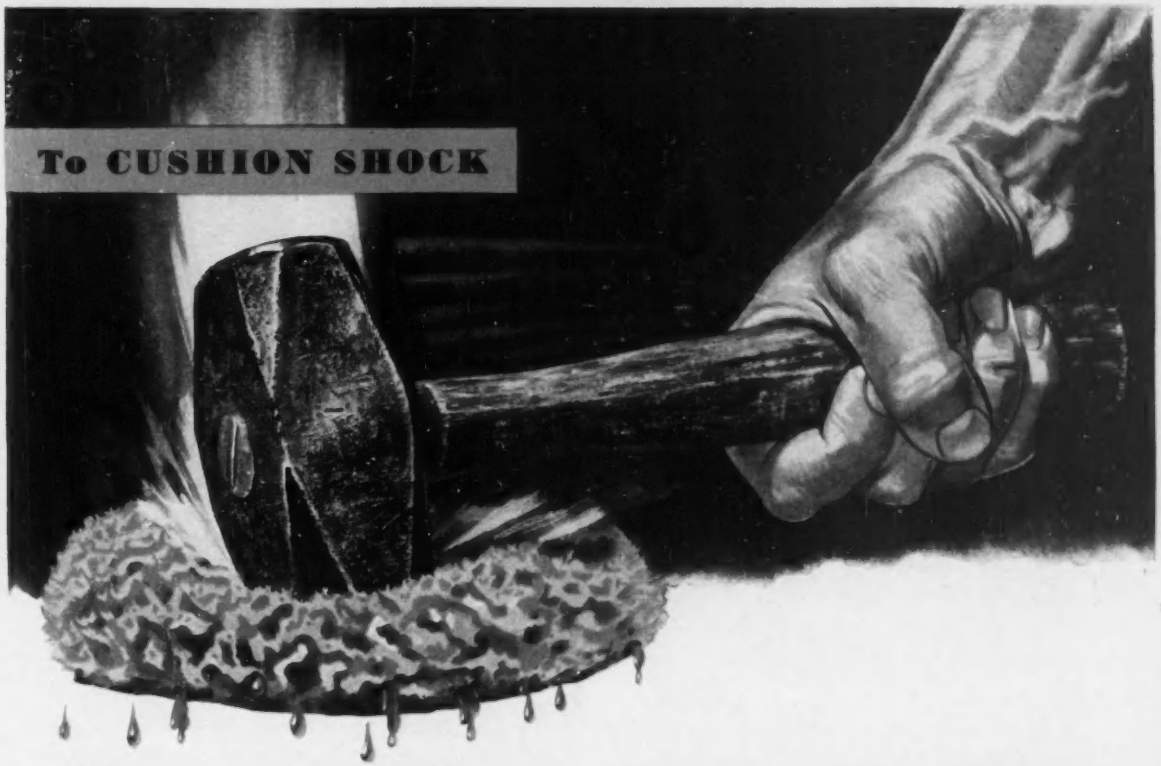


Food Processing

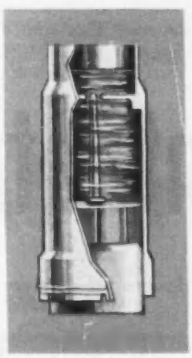
Metal Cutting



Textile Manufacturing



How we can sponge up unwanted impact with Drops of Oil!



Whatever your product—if it is subjected to unwanted impact, that impact may cost you money. Our knowledge of impact-absorption can be important to you.

Perhaps it is destructive vibration; perhaps crushing impact. We know how to control both with impact absorbers using air and oil, or oil alone, engineered for precise control.

The world's largest "impact absorbers" are the landing gears we make for giant aircraft. They cushion tons crashing to earth at tremendous velocities. The principles we apply work as well absorbing pounds as they do tons. Size is no obstacle—biggest, smallest, or in-between. Our skill has made us the world's largest manufacturer of this kind of product.

These facilities and knowledge are ready for your engineers to draw upon.

Write for the booklet which will give you a brief idea of these facilities and typical product applications.

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TOOL COMPANY
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BALL-SCREW ACTUATORS • AUTOMOTIVE SHOP EQUIPMENT
AIR-OIL IMPACT ABSORBERS

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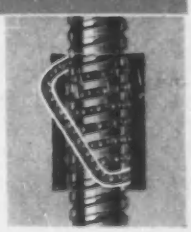
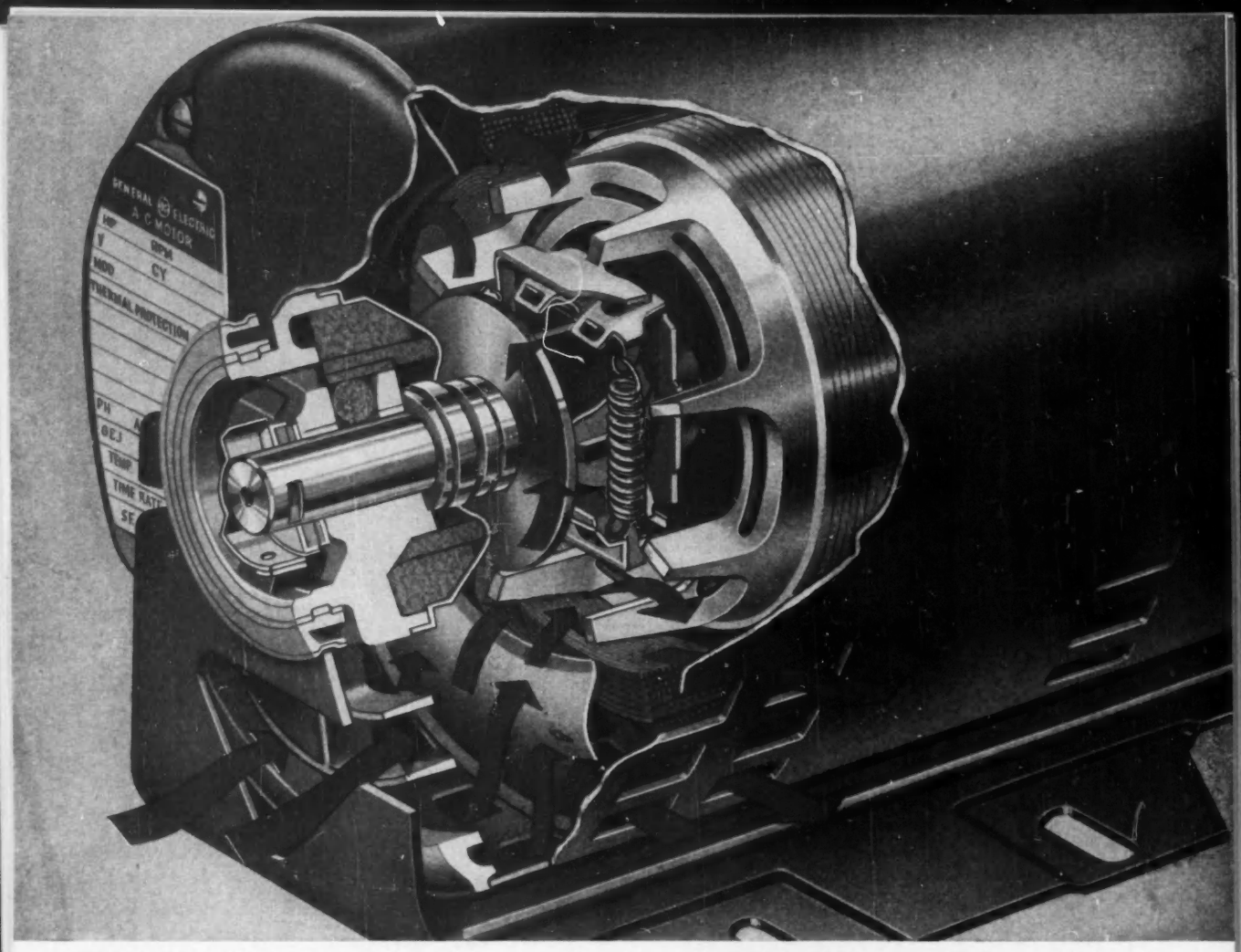
To MOVE with less EFFORT

Combining the screw with balls makes Cleveland Pneumatic's patented ball-screw actuator drive with as little as 10% friction ... compared to as much as 50% for ordinary screw drives. You can cut the weight of a drive system, reduce its space, lessen its cumbersomeness, increase its control accuracy, and provide pinpoint positioning. Let our engineers work out your ideas for our ball-screw actuators.





VENTILATION SYSTEM on new open drip-proof fhp motor pulls air in through end shield and first row of shell louvers. Baffle and fan uniformly direct the air over the windings and end rings where it absorbs heat . . . and exhausts it through the inside row of louvers. On the shaft end of the motor, air enters through the end-shield ventilating openings . . . absorbs the heat and exhausts it through the stator ventilating louvers. This controlled air flow permits more compact motor design.

New design, better ventilation

. . . reduce your assembly and shipping costs

From shipping, through storage and assembly, smaller sizes in the new G-E fhp motor line . . . as much as 40% smaller . . . bring you much easier handling and far greater economies. Applying an entirely new concept of electrical-mechanical design, the new G-E fhp motor line features an improved ventilating system that effectively dissipates heat from a reduced surface area.

In both open dripproof and totally enclosed fan-cooled motors, the ventilating system is co-ordinated as part of the basic electrical-mechanical design. This gives maximum power in minimum space.

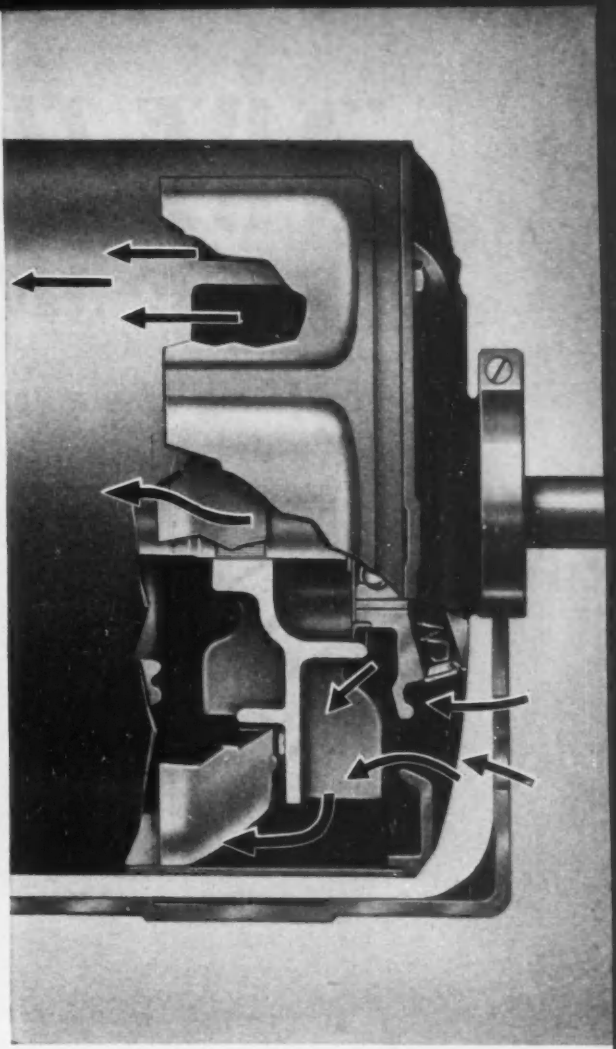
When you need motors, remember too that new G-E fractional-horsepower motors give you full NEMA performance, up to 50% less weight, all-angle operation, extra long life . . . the features you need for efficient, versatile motorization.

Find out more about the all-new G-E fhp line. Contact your nearest G-E Apparatus Sales Office, Authorized G-E Distributor, or write Section 702-4 for bulletin GEA-5567, General Electric Company, Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

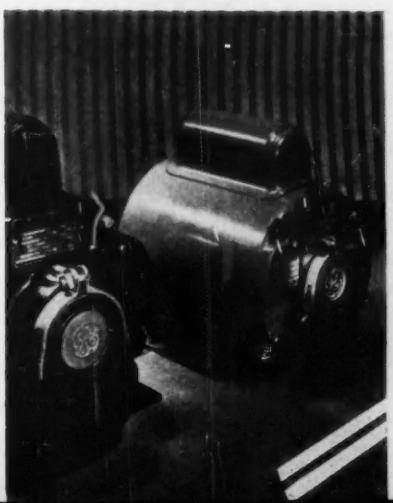
ELECTRICAL-MECHANICAL DESIGN applies new materials and techniques, providing full-rated power in smaller motor size. (1) Baffle channels air, helps prevent hot pockets. (2) Fan blades, cast integrally with the aluminum rotor windings, conduct heat from rotor for cooling.



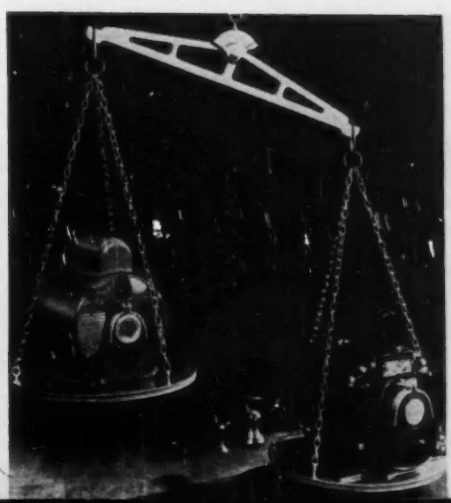
TOTALLY ENCLOSED fan-cooled fhp motors now feature both external and internal fans within stator shell. Air enters through open end shield, passes by dust-tight motor cover, and out special louvers which guide cooling blast along stator shell.

make G-E fhp motors smaller

SMALLER



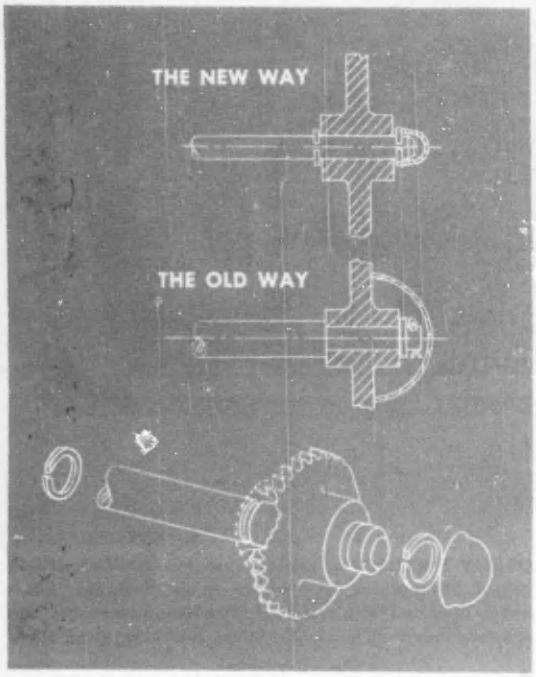
LIGHTER



BETTER LOOKING

"SAVE TIME— SAVE MATERIALS— SAVE MONEY"

will always be a great industrial slogan



Simple little retaining rings...

1. **shorten assembly time**
2. **reduce maintenance of parts**
3. **reduce weight**
4. **cut down needless space**
5. **save material**
6. ***increase ultimate profit*** **— and frequently *improve* his product at the same time.**

The world admires not only our unparalleled mass production, but our ingenious designing and *redesigning* which constantly improve and simplify *without* sacrificing strength and complete dependability.

Practically every manufacturer can improve his product—and his ultimate profit—by redesigning his machines and the construction details of his products.

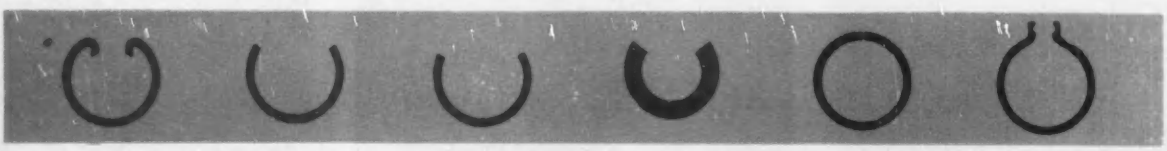
The use of these inexpensive yet efficient artificial shoulders is already widespread—and is increasing constantly.

Every product—metal, wooden or plastic—should be examined carefully to see where shoulders and collars could be redesigned to use these steel rings.

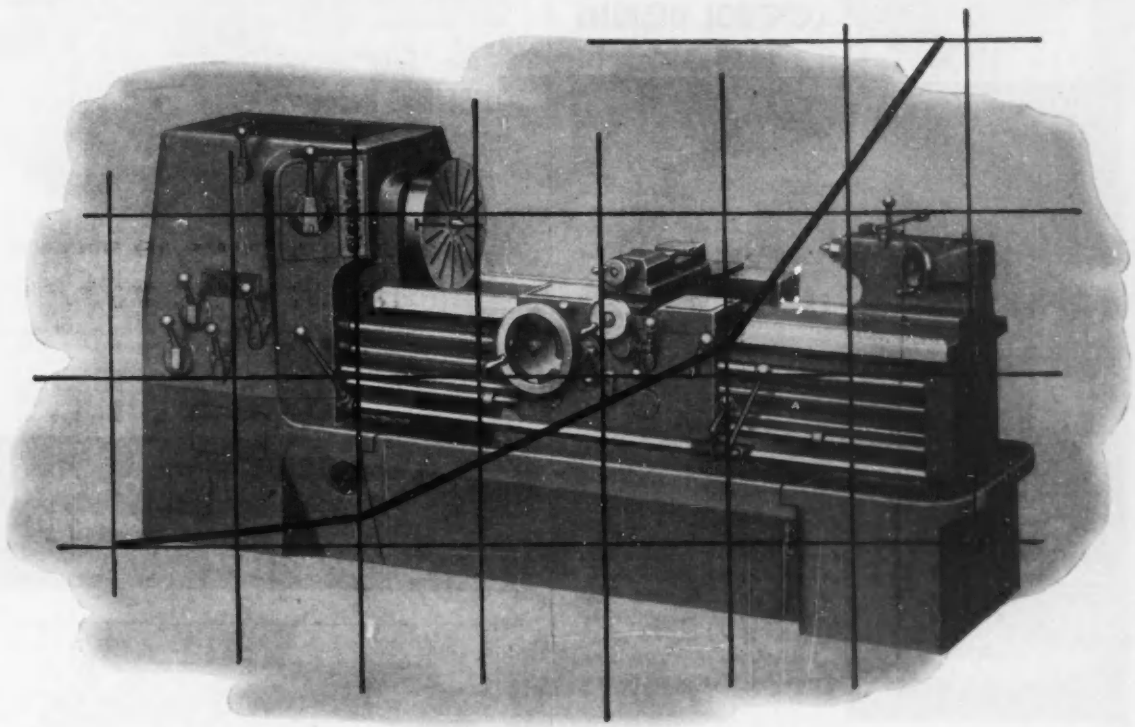
Write today for descriptive booklet.

THE NATIONAL LOCK WASHER CO.

NEWARK 5, NEW JERSEY • MILWAUKEE 2, WISCONSIN, U. S. A.



HAVE YOU CHECKED *Your* PRODUCT'S EQ* LATELY?



MAYBE ITS *EFFICIENCY QUOTIENT NEEDS THE LIFT AETNA ANTI-FRICTION PRODUCTS CAN GIVE

Throughout industry you'll find Aetna precision bearings and parts improving the efficiency and serviceability of today's products and the machines that make them . . . and contributing to the developments of tomorrow.

As a result of Aetna's faculty of solving the sort of anti-friction problems that "couldn't be solved" manufacturers have often realized startling economies or licked tough merchandising problems that stymied sales.

Tell us about YOUR "tough" bearing or parts problems. It's a pretty certain bet that our engineers will be ready with the right answers—at the right prices—for our vast pool of tools and dies, acquired in creating more than 2000 "specials" for industry, usually enables us to meet unique requirements without the expense of new tooling. Just state your problem, send your prints or ask that a nearby representative drop in. No obligation.

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AETNA BALL AND ROLLER BEARING COMPANY

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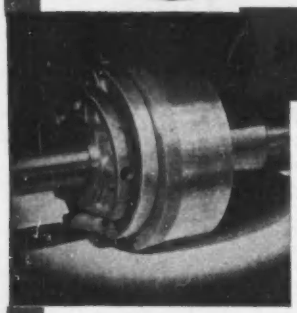
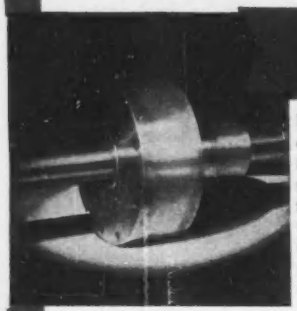
HILLIARD Clutches

FOR POWER CONTROL DESIGNS



Unequaled for accurate control of intermittent machine operations—cutting, punching and packaging. Gives closer tolerances to cut-off, stamping, shearing and similar machines. Completely automatic; manual, mechanical or electrical control.



Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unsurpassed for automatic two-speed drives, dual drives, stand-by drives and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.

A reliable series of spring-loaded slip clutches and couplings. Rugged construction with ample friction surface for heavy-duty use. Outstanding for preventing overloads and shocks; for starting heavy loads; as tension drag brakes; for reeling and winding operations and many other uses.

★ HILLIARD CLUTCHES and COUPLINGS make machine drive and power transmission more efficient and economical. Experienced engineers will be glad to offer their advice on any problems. Complete descriptive material will be furnished on request.

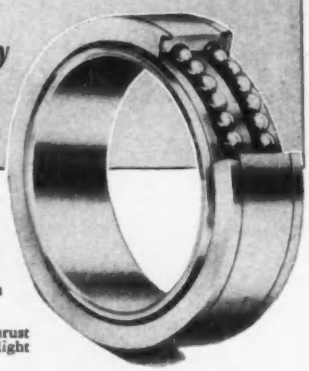
WRITE TODAY for our illustrated brochure #MP-4 for information.

CLUTCH MAKERS FOR OVER FORTY-FIVE YEARS

101 W. FOURTH STREET, ELMIRA, N. Y.

In Canada • • • **UPTON - BRADEEN - JAMES, LTD.**

...for maximum anti-friction bearing capacity in minimum section space...



. . . use "Split" BALL BEARING Bushings

. . . require only ¼" section height

. . . stability, radial and thrust capacity provided in very light section.

. . . life of equipment in which application is made increased without adding excessive weight.

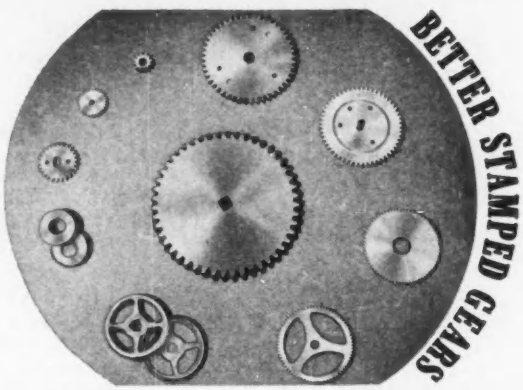
. . . costly methods of introducing lubrication are eliminated by prelubrication.

. . . problems of both designers and users are solved by these bearings. Investigate NOW!

Ask for folder containing sizes and load capacities. Call on our Engineering Department for advice and help on your problems.

SPLIT BALLBEARING CORP.

LEBANON NEW HAMPSHIRE



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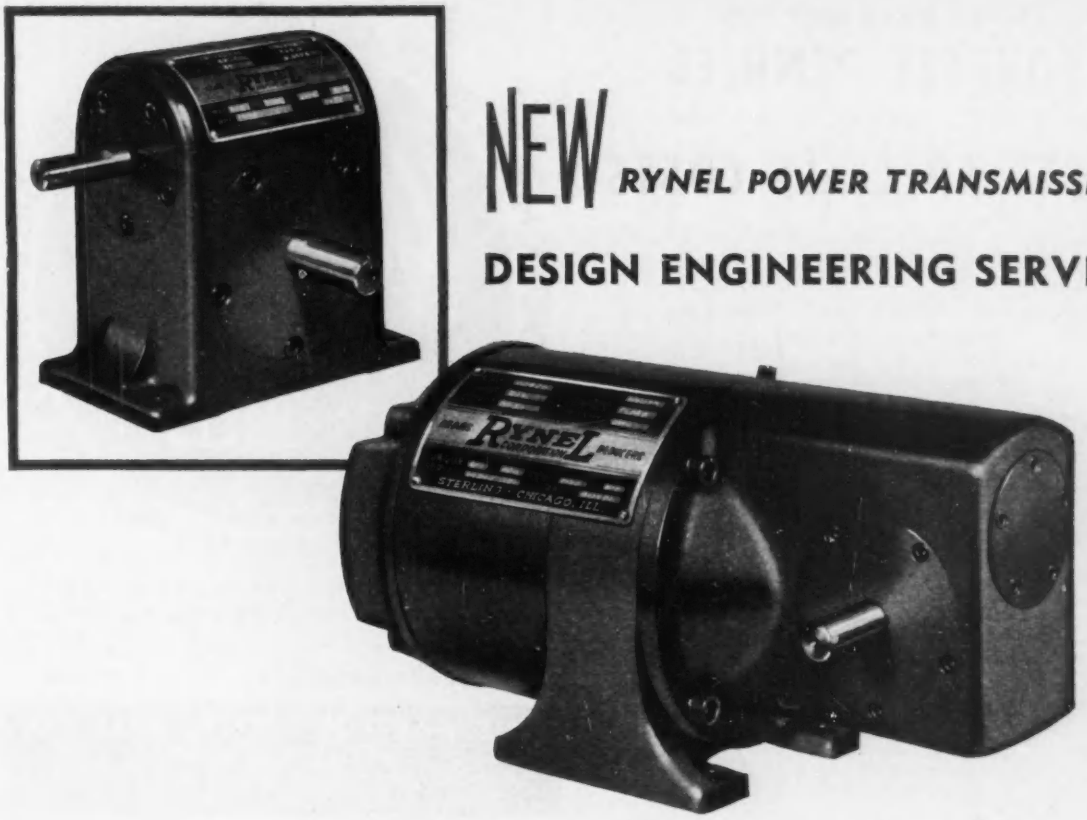

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GEARMOTORS SPEED REDUCERS *with High Overhung Load Capacities*

Rynel Speed Reducers and Gearmotors are offered in a range from 1/50 to 5 H.P. and 1" to 8" centers, with any desired ratios practical in this range.

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Right Angle
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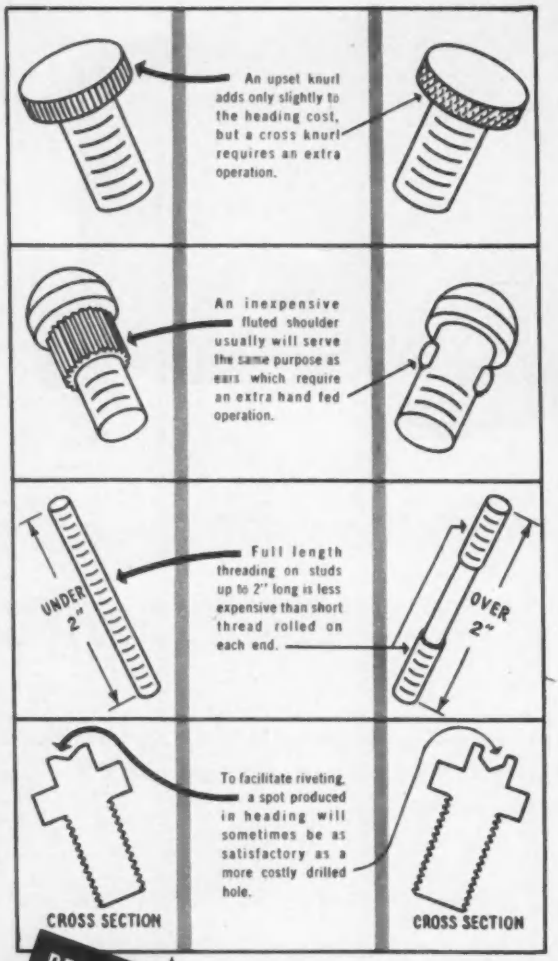
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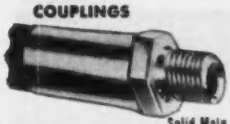

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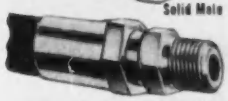

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Swivel Female

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1-Wire Braid Hose

2-Wire Braid Hose

1-Fabric Braid Hose

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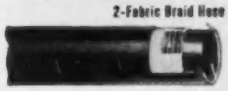

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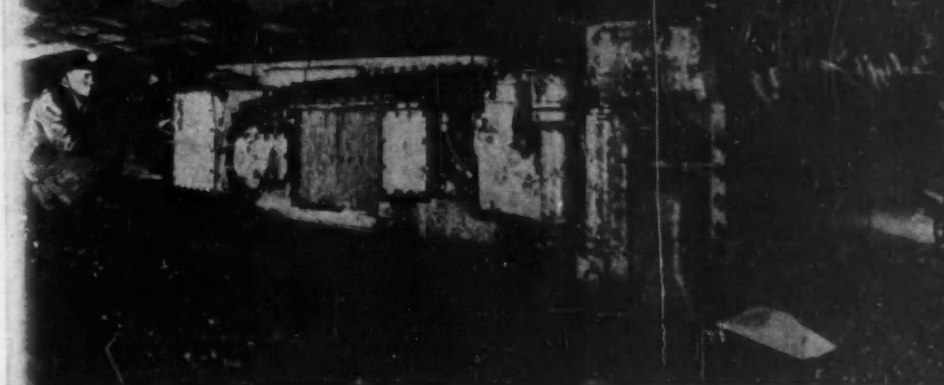

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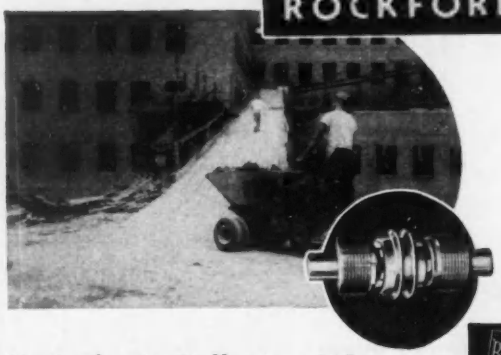

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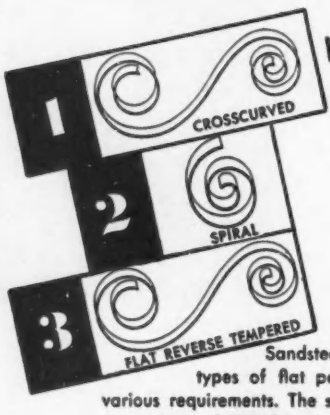

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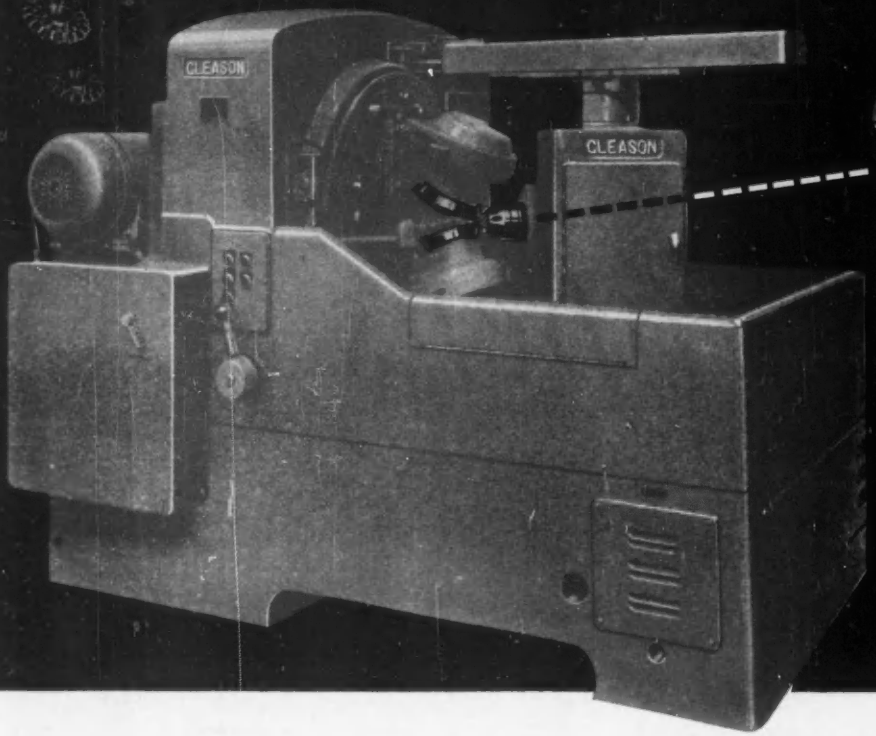

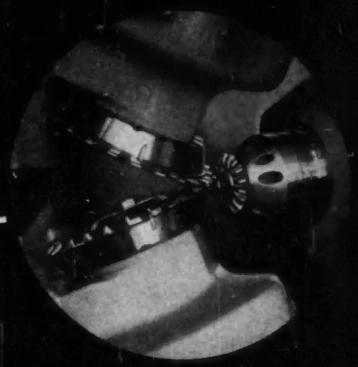

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DESIGNING WITH ALUMINUM

NO. 5

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

STRENGTH AFTER WORKING

RATES OF GAIN IN YIELD AND TENSILE STRENGTHS VARY FOR DIFFERENT ALLOYS

WROUGHT ALUMINUM alloys are being increasingly used for formed pieces, parts and articles where specified strength is a prime requirement. This makes more important the development of quantitative data concerning the increase in yield and tensile strengths that occurs during forming operations.

The phenomenon of strain or work hardening, of course, has long been known. It applies to both the non-heat-treatable and heat-treatable aluminum alloys. But its influence is of major practical concern only in the case of the non-heat-treatable (sometimes loosely called "common") alloys because the final strength of a product formed from them is determined by that of the original material plus whatever is added by the working of the metal during fabrication.

The non-heat-treatable alloys are logically the first to be considered, and are in fact most generally used in applications where forming requirements are moderate to severe. Where development of their fullest strength is desired, it is frequently possible to start with metal in an intermediate, rather than the annealed, temper if the required forming is not too severe.

Research Tests Show Changes from Stretching

Tests conducted by Kaiser Aluminum's Division of Metallurgical Research have produced interesting and significant data concerning the relative increases, after varying amounts of stretching, in both yield and tensile strengths and the rate of work hardening for four of the alloys usually used for forming. These data may be helpful as a guide in both design and alloy selection.

Specimen strips of .040" thick 2S, 3S, 50S and 52S sheet were first tested in the annealed ("O" temper) condition, then stretched specified amounts in a Baldwin-Southwark testing machine and tested again after stretching. The tests were made with the grain of the metal, and in the same direction in which the samples were stretched.

The results are shown in Figs. 1 to 4. These curves are plotted in terms of yield and tensile strength after stretching, the relative percentage increase in yield strength for a given amount of stretching and the rate of work hardening.

Emphasis was placed on the changes in yield strength because of its importance as a guide to dent resistance in many formed products, where denting frequently is a cause for rejection.

The relationships between these four alloys as shown in the charts are of particular interest when they are considered in conjunction with cost, fabrication problems and service requirements. For instance, it is clear why use of 2S, although it is the most economical of these alloys and possesses high ductility, is declining except where there are minimum strength requirements. It is evident as well that good strength in the finished product may be obtained with 52S, although its more rapid work hardening rate indicates the fabrication considerations which may be involved by comparison with 3S and 50S, whose work hardening rates and strengths are more moderate.

Fig. 1. Effects of stretching upon yield strength.

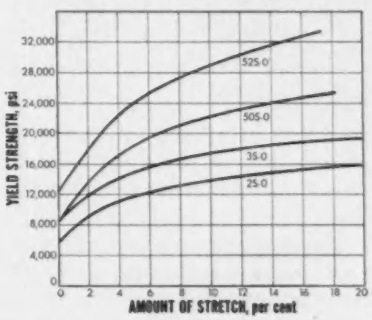


Fig. 2. Effects of stretching upon ultimate strength.

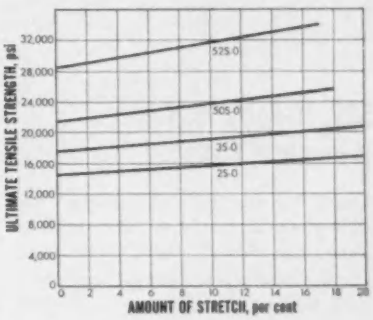


Fig. 3. Rate of work hardening during stretching. Curves plotted from tangents to curves in Fig. 1.

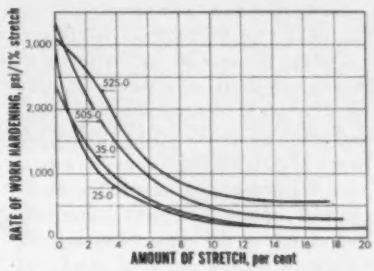
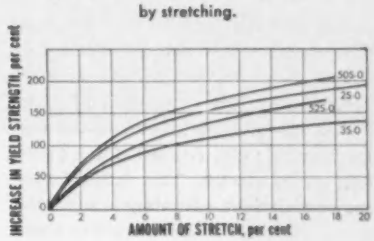


Fig. 4. Increases in yield strength caused by stretching.



PLEASE TURN TO NEXT PAGE ➡

TABLE I Comparison of Properties in Crisper Pans Drawn from .040" 3S-0 and 50S-0 Sheet

Alloy	Location	Thickness, inches	Direction of Test	Ultimate Strength, psi	Yield Strength, psi	% Gain in Yield Strength For 50S
3S	Flanges	.0426	----------	18500	17700	
50S	Flanges	.0440	----------	25600	24500	38
3S	Ends	.0373	With grain	17250	16400	
50S	Ends	.0386	With grain	25700	22300	36
3S	Ends	.0346	Across grain	17950	17700	
50S	Ends	.0352	Across grain	27080	25100	42
3S	Sides	.0338	With grain	20000	19200	
50S	Sides	.0349	With grain	27550	26100	36
3S	Sides	.0375	Across grain	17625	16750	
50S	Sides	.0385	Across grain	25750	23200	38

50S, 3S Performance in Identical Piece

Along with the tests of specimens described above, tests were also made of production-formed pieces made from alloys 50S and 3S. The test specimens were taken both with and across the grain from identical refrigerator crisper drawers drawn from .040" sheet in each case.

The results, tabulated in Table 1, demonstrate the advantage obtained in this application deriving not only from the higher original strength of 50S over 3S but also from its greater percentage increase in yield strength for a given amount of stretch. This latter factor can be of decided advantage in strengthening sections of an item which by their nature receive minimum working during fabrication.

Depending upon the location from which the specimens were taken, the yield strength due to forming was from 36% to 42% greater for the 50S drawer, a substantial gain over the increase in yield strength of the 3S pan.

These tests all serve to re-emphasize the importance of giving careful consideration to all factors involved in selecting the aluminum alloy for a particular application, as well as the versatility provided by the entire family of aluminum alloys.

Many Alloys Provide Good Formability

Aluminum is generally known as one of the most easily formed metals. An accurate measure of formability has yet to be developed, although it is possible to draw general conclusions from an analysis of mechanical properties.

The spread between the tensile and yield strengths, and the per cent elongation provide indications of the formability of a particular alloy. In general, the more severe the operation, the greater both these measures should be.

Elongation is a measure of ductility, but cannot be considered by itself as a criterion of formability in practice. Material must be stressed beyond the yield strength to deform plastically and retain the desired new shape. However, if the forming stresses should exceed the tensile strength, the material will rupture (fracture): hence, the importance of the spread between the yield and tensile strength values. In this connection it is often found that a stronger temper of the same alloy may provide better formability because of its ability to withstand higher forming pressures.

Most of the generally used wrought aluminum alloys possess good spreads and elongation in their annealed (O) tempers. This is true of the heat-treatable alloys as well as the non-heat-treatable alloys.

It is not to be overlooked, however, that even complicated forming can be and is being done regularly with the heat-treatable aluminum alloys, including those of the highest strength, after solution heat treatment but before aging to maximum strength. This is possible because after the quenching that concludes solution heat treatment the heat-treatable alloys remain quite soft for varying periods of time. Within a few minutes the alloying constituents begin to precipitate as extremely small particles in the solid metal, and the strength at room temperature begins to increase. Some alloys, 24S for example, "age" rapidly to maximum strength; normally, others are artificially aged by a process termed precipitation heat treatment, which is a low-temperature thermal treatment.

It is in the interim period between quenching and aging that much forming can be done. This period may be prolonged by refrigerating the metal, which prevents or retards precipitation of the alloying particles. Formed parts are subject to a minimum of distortion in the low-temperature precipitation heat treatment that then follows. This general method is used extensively by aircraft manufacturers in stretch forming sections of considerable area.

Technical assistance in connection with aluminum alloy selection and fabrication techniques may be obtained through Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California. Copies of a product information book on aluminum sheet and plate, containing comprehensive tables, may also be obtained on request.

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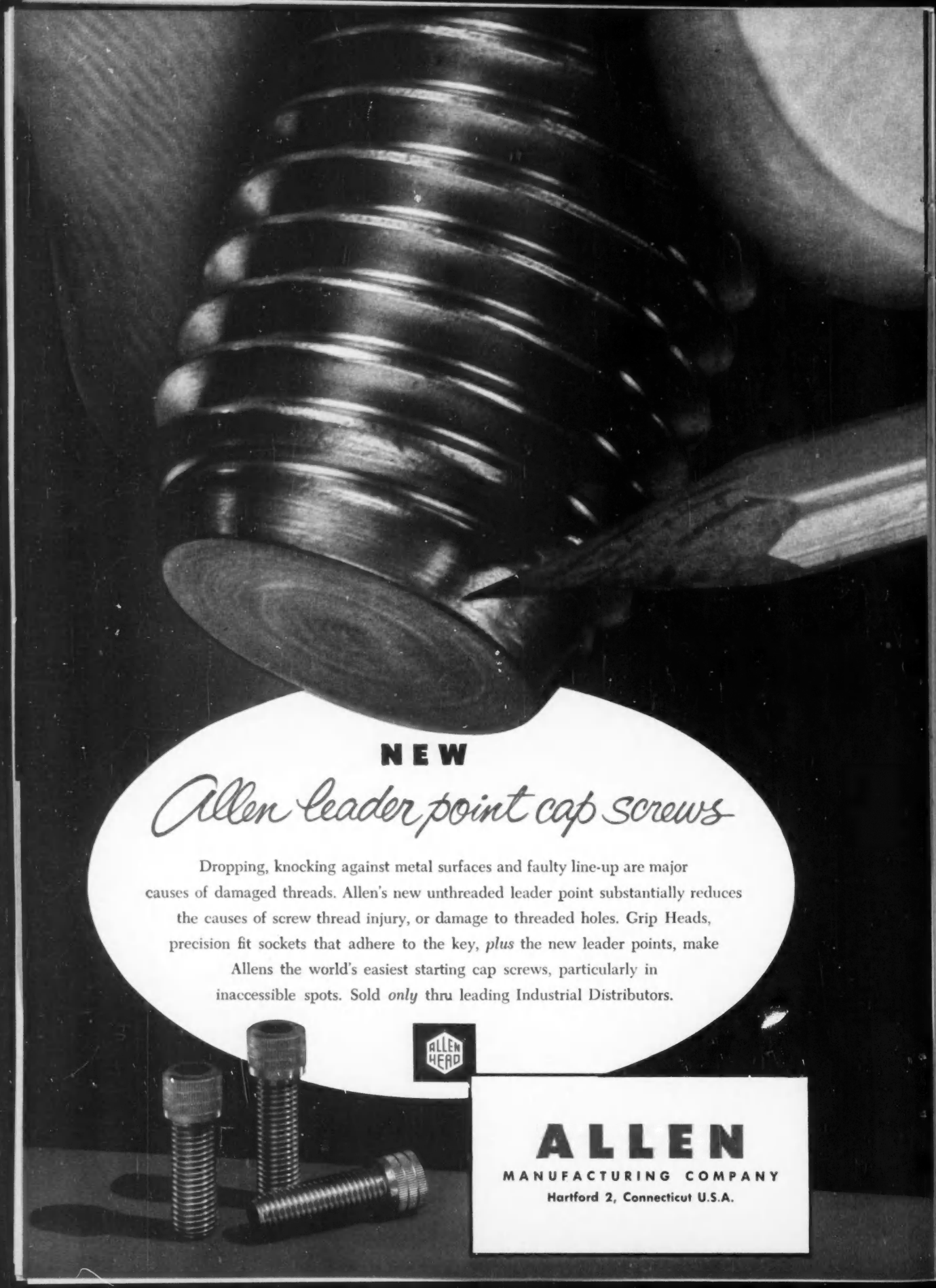
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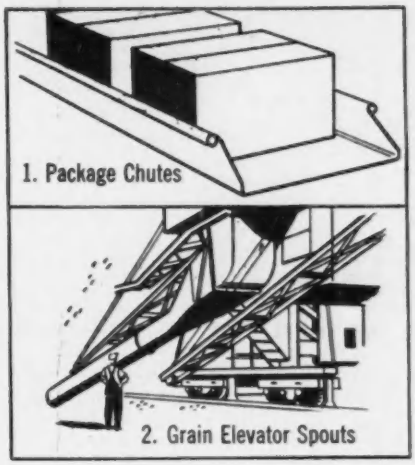

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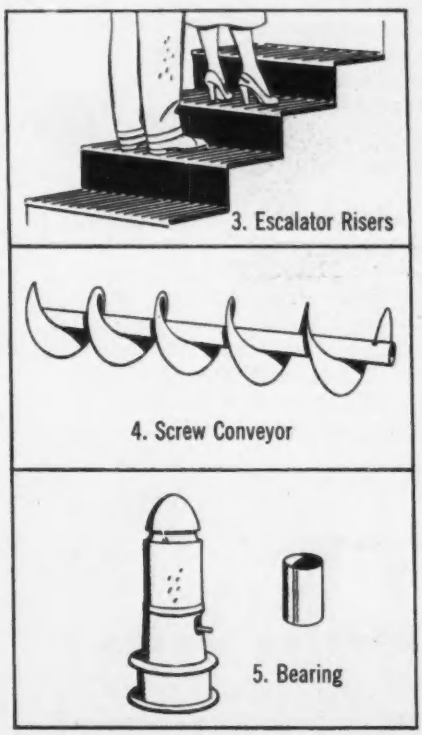

MEASURED by scratch test using Moh's scale, the hardness of Porcelain Enamel is between 5 and 6 for most grades. This compares to a Knoop hardness of about 360-560.

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There's a marked difference in cylinders, too. As in the case of many other products, it isn't always apparent to the naked eye. It's there, nonetheless, and over a period of time the difference makes itself known. If, on occasion, you have been quoted a higher price on Hanna cylinders than on competitive cylinders, you may have wondered what accounts for the difference. What exactly are the differences that make Hanna cylinders a better investment?

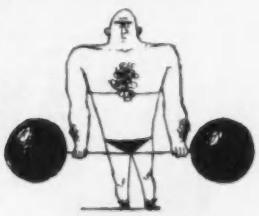
Well, for one thing, the tube of every Hanna H-P cylinder is centrifugally cast Meehanite (1-1/16″ av. thickness), accurately bored and honed for low friction and perfect oil seal. Cast Meehanite is used because it lends cylinder tubes greater dimensional stability and more stubborn resistance to external damage.

There's a pronounced difference, too, between the head of most cylinders and the Hanna cylinder head. In the Hanna product, large, metal-to-metal contact area between cylinder head and tube prevents cocking and assures squareness of mounting surfaces to the bore.

Hanna rod packings are designed for a more efficient seal and longer, trouble-free cylinder life. The spring-backed rod packings provide compensation for friction and wear.

The piston and rod of a Hanna cylinder are constructed of either a single piece of high carbon steel to assure concentricity and maximum strength, or assembled with shrink-fit welded construction and machined after assembly. In the latter case, ends are relieved to prevent wall scoring.

Even the assembly screws of a Hanna cylinder boast a feature found in few competitive cylinders. The heat-treated alloy socket head screws are closely spaced for maximum strength and countersunk into heads for a clean-cut appearance. Non-tie rod construction further enhances the streamlined design.



These, in the main, are the features that set Hanna cylinders apart from most other cylinders. Once you've used Hanna H-P cylinders, we're sure you'll agree their improved performance and longer life more than justify any small difference in cost. May we suggest that you bear this in mind next time you invest money in cylinders?

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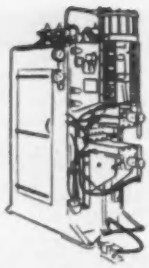
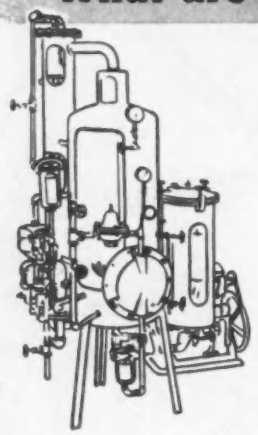
HYDRAULIC AND PNEUMATIC EQUIPMENT • CYLINDERS • VALVES • RIVETERS

ELECTRICAL
CORDS
KEEP YOUR APPLIANCES
IN SERVICE
Belden
MANUFACTURERS WHOSE PRODUCTS SERVE BEST...
Specify Belden
WIREMAKER FOR INDUSTRY



WELDING MACHINE

What are your VALVE NEEDS?

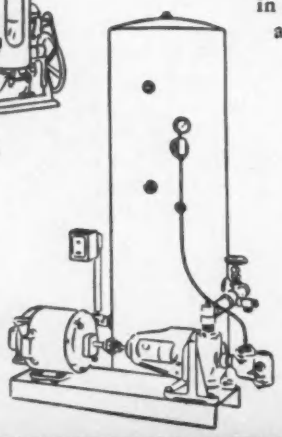


LAUNDRY PRESSING EQUIPMENT

Do you have to meet a lower production cost in the valve you select? Has a certain valve capacity got you stumped? Then call on CASH-ACME.

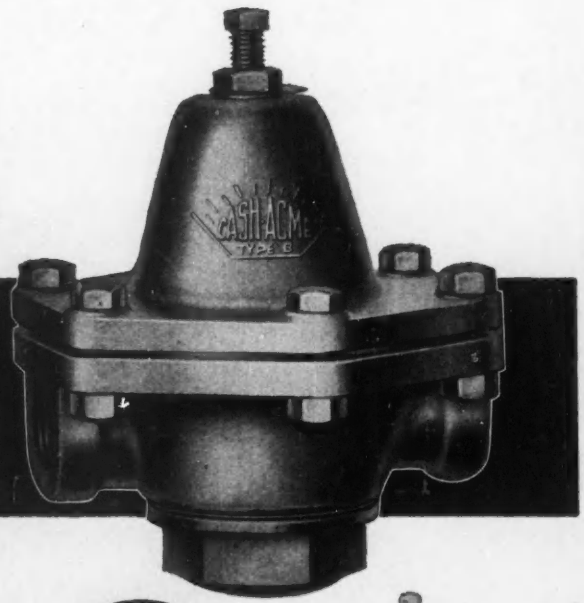
Many pressure control needs can be filled with a CASH-ACME valve at surprisingly lower cost. If one of our standard valves is not suitable for your requirements, we are able in many cases to modify the standard valve or design a new one for particular requirements.

Mail the coupon below with a brief outline of your installation requirements. A free booklet or catalog on request.



WATER PUMP

Cash-Acme has the ANSWER...



ATTACH TO YOUR LETTERHEAD
A. W. Cash Valve Mfg. Corp.
6662 E. Wabash Avenue
Decatur, Illinois

☐ Please send me your free booklet.

NAME_____

FIRM_____

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To save time may we suggest a brief outline of your requirements be mailed with this coupon.

CASH ACME

SILENT SENTINEL
Automatic Valves

A. W. CASH VALVE MFG. CORP.
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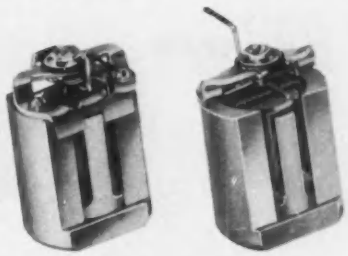
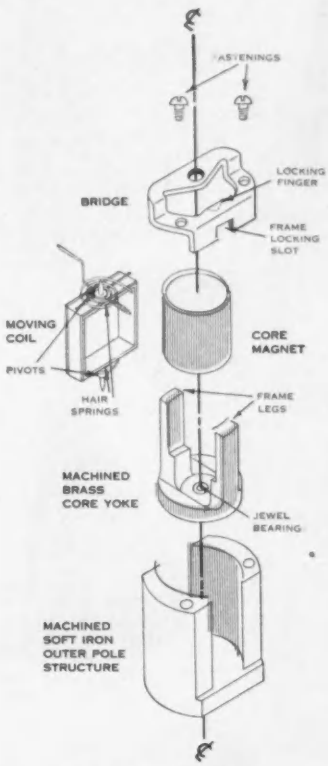
marion

advancement in instrument design



TWO VIEWS SHOWING COAXIAL MECHANISM
ACTUAL SIZE
(Total Weight 0.8 oz.)



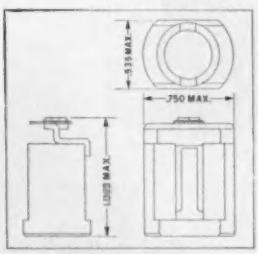
EXPLODED DIAGRAM SHOWING INTERLOCKING CONSTRUCTION

COAXIAL METER MECHANISM DESIGN* OPENS NEW FIELDS OF APPLICATION

A new Marion concept in the mechanical design of the moving coil galvanometer magnetic system has resulted in a "miniature" movement with performance characteristics and durability exceeding existing ruggedized or regular panel instruments of far greater size and weight. The Marion "Coaxial" assembly provides a magnetic field of great strength, uniformity and stability which is self-shielded. Ruggedness and stability are inherent in the basic simplicity of the design. The small size and weight make practical the application of the moving coil mechanism as a component of a great many electrical or electronic instruments or other products. This is especially pertinent in aircraft instruments where size and weight are of critical importance, yet no compromise can be made with performance and durability.

The new assembly (see exploded diagram) consists essentially of a soft iron outer pole structure, a non-magnetic yoke and a magnetized core of such diameters that the yoke fits snugly in the pole structure and the core within the yoke. The assembly is locked by attaching the bridge to the pole structure by means of two screws — the only fastenings in the entire assembly. A locking finger on the bridge holds the core and the frame in position. Rotation of the core yoke is prevented by the slot in the bridge flange which engages one of the legs of the frame. The moving coil is contained by its pivots, and bearings located in the bridge and the base of the frame.

The basic design in which all critical dimensions are machined from a common center (the bearing axis) gives far more precise and uniform alignment than is possible with stamped assemblies. The interlocked assembly assures maintenance of these close tolerances and affords far greater rigidity and strength than is available in conventional mechanisms, particularly when mass is considered.



MECHANISMS BY MARION

The Marion "Coaxial" mechanism has many applications, not only in indicating instruments, but also as a component of equipment utilizing the moving coil galvanometer principle. It is one of a number of Mechanisms by Marion that extend the field of application of moving coil galvanometers where previously size, weight or performance characteristics prevented their use.

Marion Electrical Instrument Company, 415 Canal Street, Manchester, N. H.

*Patents Pending

marion meters

Reg. U. S. Pat. Off.

MANUFACTURERS OF RUGGEDIZED AND "REGULAR" METERS AND RELATED PRODUCTS

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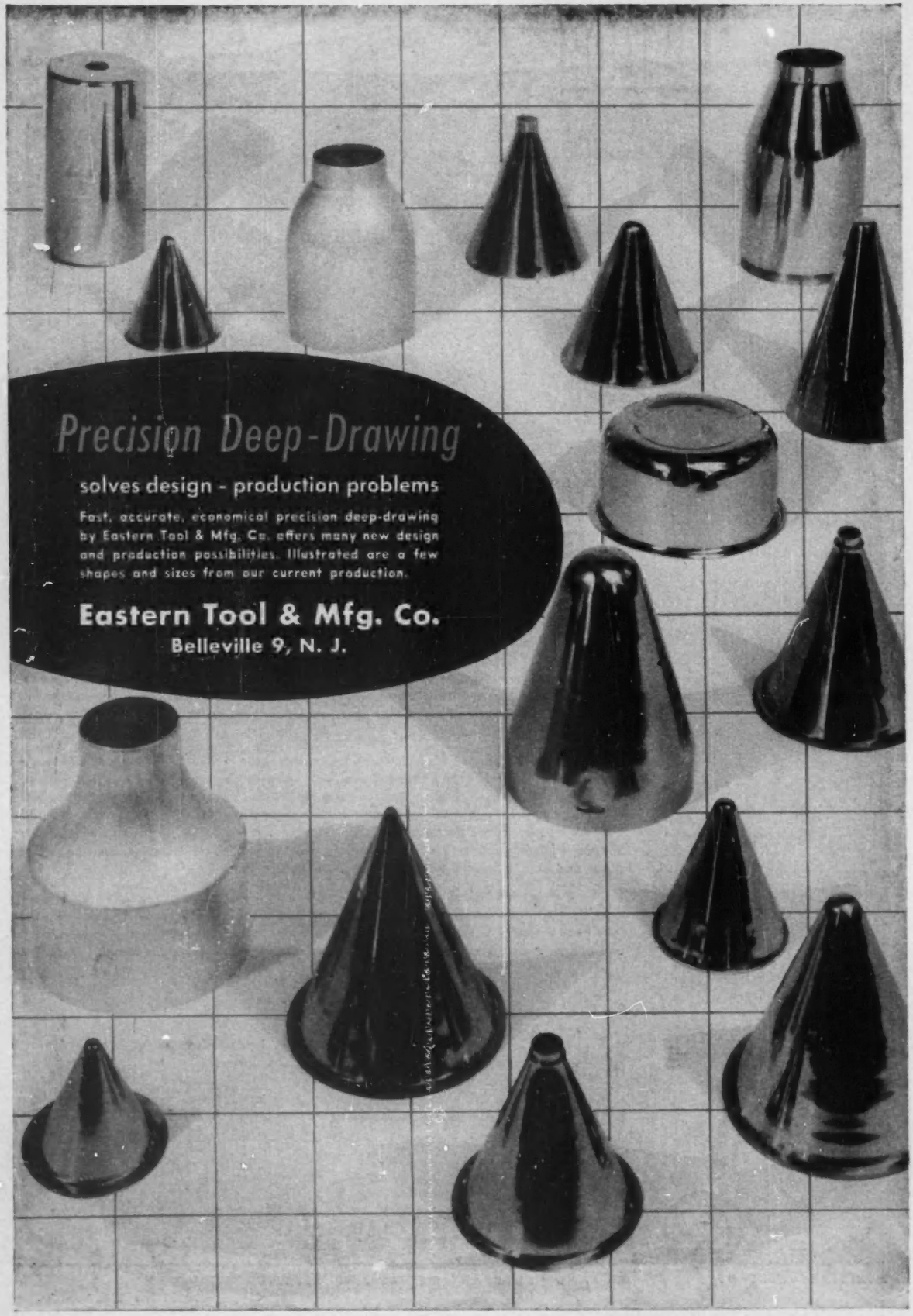
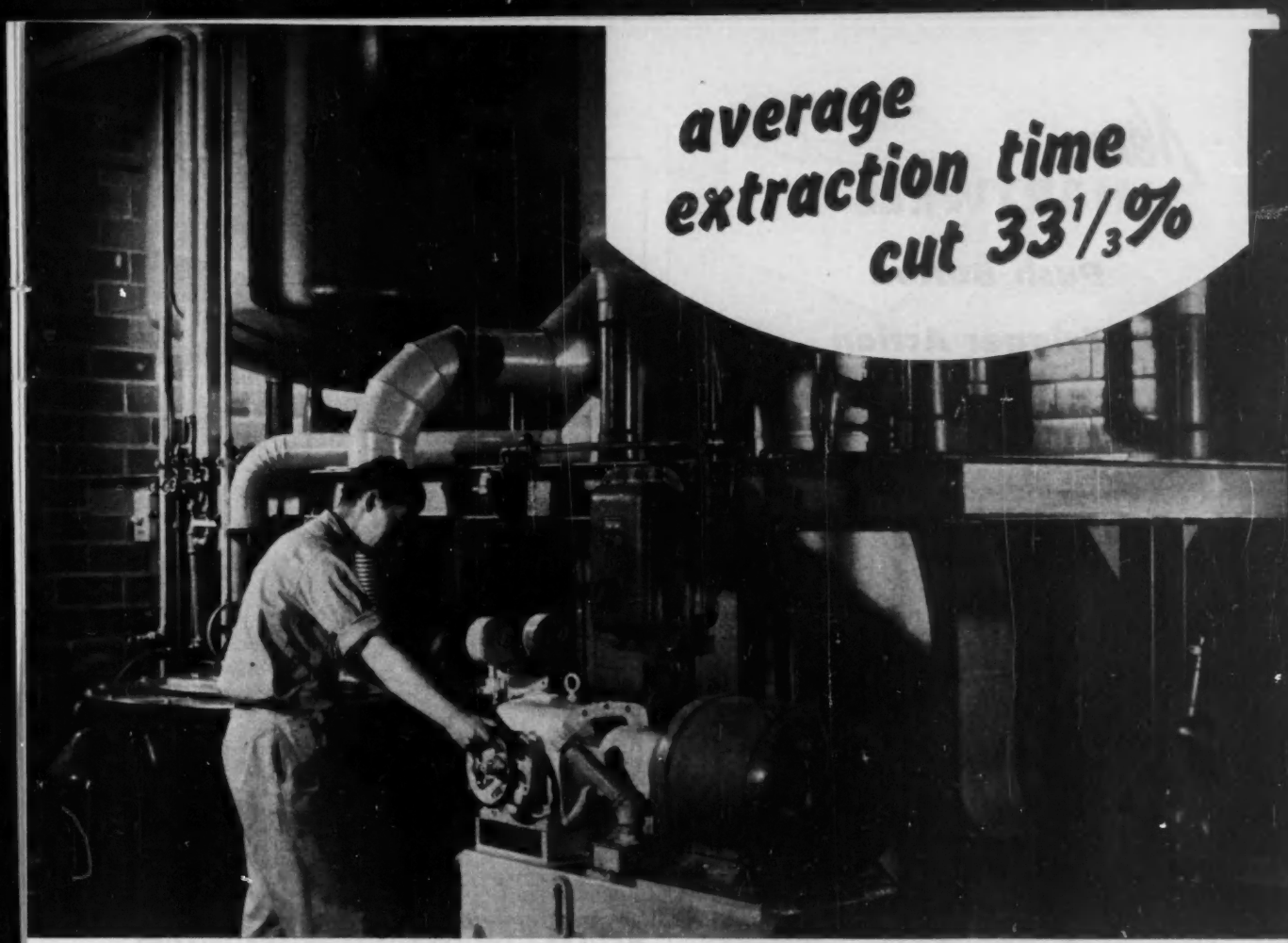

Precision Deep-Drawing
solves design - production problems
Fast, accurate, economical precision deep-drawing by Eastern Tool & Mfg. Co. offers many new design and production possibilities. Illustrated are a few shapes and sizes from our current production.
Eastern Tool & Mfg. Co.
Belleville 9, N. J.



Once more the ANY-SPEED Oilgear Drive betters machine performance "painlessly"

Many times in our experience the performance of an already highly efficient machine has been bettered without redesign, solely by changing the drive. One case out of many *varied* cases, is the Tolhurst Centrifugal pictured above, located in a great pharmaceutical house. This centrifugal was originally equipped with a two-speed electric motor drive. However the chemicals it is called upon to handle have widely varying crystal packing characteristics. Some of these crystals packed so densely at the speed available, extraction was inhibited, extraction time far out of balance and crystal removal difficult.

A change was made to an *"ANY-SPEED"* Oilgear Fluid Power Drive. Now the operator is able to shade the speed of the centrifuge experimentally—*and easily discover* the *best* speed for each batch of crystals.

As a result, extracting that used to take from 6 to 9 hours was cut to 4 to 6 hours. The extremely slow speed also available made unloading a great deal easier. This user now has several other Oilgear drives including one on a laboratory centrifuge.

There is very often a direct efficiency coefficient between machine operating speed and the type of work being handled. And we can cite many widely varying instances where equally dramatic and profitable gains resulted at once from a simple change to *"ANY-SPEED"* Oilgear Fluid Power Drives. If you want some interesting factual data on Oilgear's steplessly variable speed drives, their outstanding responsiveness to control impulses, their smooth acceleration and deceleration, talk to an Oilgear Engineering Representative. His mature and sound engineering recommendations may profit you greatly. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wisconsin.

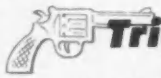
OILGEAR

OILGEAR

New

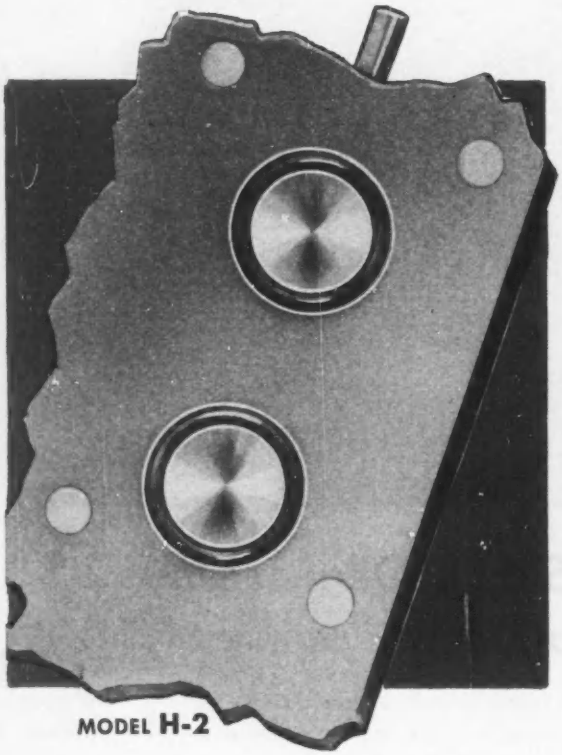
HARTWELL

Push Button



Trigger Action

FLUSH LATCH



MODEL **H-2**

● A new latch development for modern equipment. Combines the desirable features of push button operation with the positive simplicity of trigger action in a small, rugged, lightweight yet inexpensive flush latch.

Available in many offset combinations for various door and frame thickness arrangements. Standard with or without gaskets in stainless steel or cadmium plated cold rolled steel.

Write for new 1954 Flush Latch Catalog

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COMPANY

Manufacturer of Flush Latches and Hinges, Fittings and Cable Terminals.

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FOR EVERY APPLICATION

COMPRESSION • TORSION

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METAL STAMPINGS &

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Get Easier, More Accurate Cylinder Speed Control

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Pneu-Trol

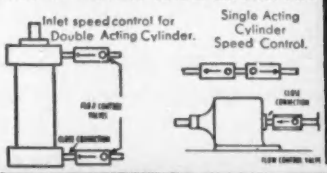
VALVES

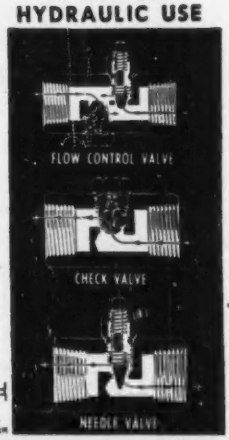
IN AIR OR HYDRAULIC USE

2000 and 5000 (steel) P.S.I.

Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check Valve and Needle Valve incorporate single function features of Flow Control Valve. All valves available in 6 female pipe sizes — ⅛" to ¾". Valve bodies are made from brass, aluminum, steel or stainless steel. Attractive Prices — Immediate Delivery.

Write for Illustrated Circular and Price List.





Pneu-Trol Devices, Inc.

1428 N. Keating Ave., Chicago 51, Ill.

for **High Strength** and

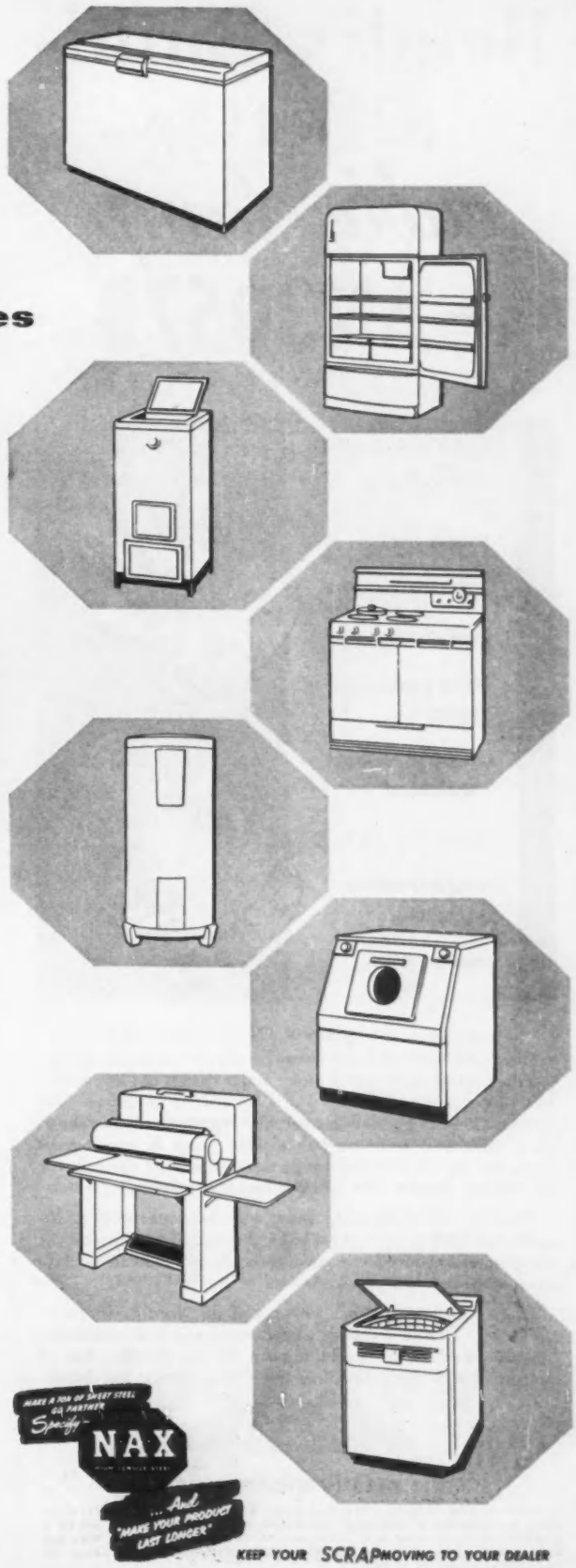
Longer Life in

Household Appliances

Specify

N-A-X

HIGH-TENSILE STEEL



N-A-X HIGH-TENSILE, having 50% greater strength than mild carbon steel, permits the use of thinner sections—resulting in lighter weight of products, yet with greater resistance to denting. It is a low-alloy steel—possessing much greater resistance to corrosion than mild carbon steel, with either painted or unpainted surfaces. Combined with this characteristic, it has high fatigue and toughness values and the abrasion resistance of a medium high carbon steel—resulting in longer life of products.

N-A-X HIGH-TENSILE, with its higher physical properties, can be readily formed into the most difficult stamped shapes, and its response to welding, by any method, is excellent. Due to its inherently fine grain and higher hardness, less surface preparation is required for either painted or plated parts.

Your product can be made lighter, resulting in shipping economies to consumer . . . to last longer . . . and in some cases be manufactured more economically, when made of N-A-X HIGH-TENSILE steel.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division — Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

MAKE A TON OF SHEET STEEL GO FARTHER — Specify — NAX — ... And "MAKE YOUR PRODUCT LAST LONGER"

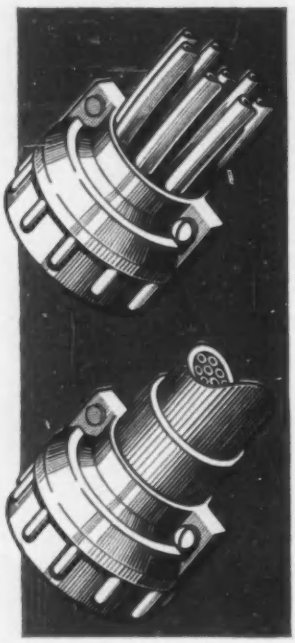
KEEP YOUR SCRAP MOVING TO YOUR DEALER

Bendix Builds a Better *cable clamp* the AN3057B

Inexpensive Efficient Versatile

Outstanding Features

- Neoprene gland.
- Centered clamping action.
- Increased close down.
- Positive grounding feature.
- Cadmium plated die-cast aluminum nut.
- Shorter over-all length.
- Waterproofs multi-conductor cable.
- Immediate delivery.



The new Bendix AN approved AN3057B cable clamp is now available. Engineered by Bendix to the highest quality standards, this cable clamp offers major design improvements. The clamping action is radial and completely eliminates wire strain and chafing by holding the wire bundle firmly in rubber. This clamp will accommodate a wide range of wire bundle sizes, but an even greater range can be handled through the use of the Bendix AN3420A accessory telescoping sleeve.

The new AN3057B cable clamp will also waterproof multi-conductor rubber covered cable on the rear of a connector, or where moisture-proof entrance through a bulkhead or into an equipment box is required.

This versatile clamp is a product of the Scintilla Magneto Division of Bendix Aviation Corporation and is a companion AN accessory to the world famous Bendix Scinflex line of electrical connectors. Write our Sales Department for details.

Bendix

SCINTILLA MAGNETO DIVISION of Bendix

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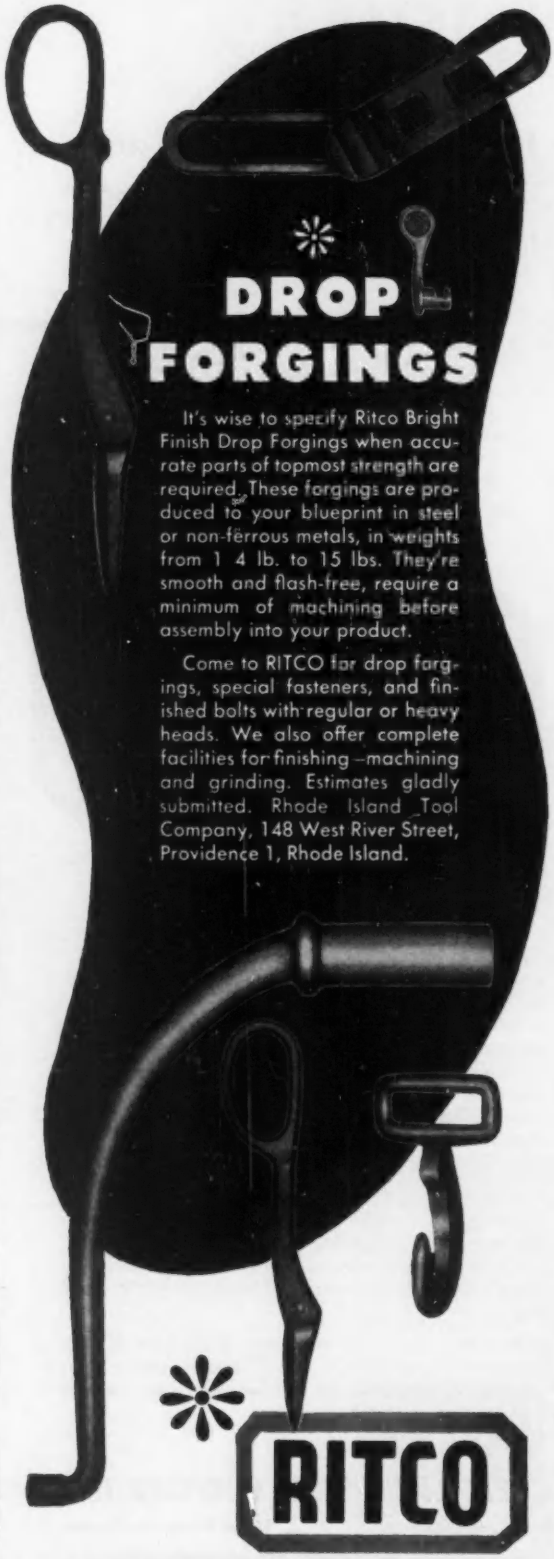


DROP FORGINGS

It's wise to specify Ritco Bright Finish Drop Forgings when accurate parts of topmost strength are required. These forgings are produced to your blueprint in steel or non-ferrous metals, in weights from 1 4 lb. to 15 lbs. They're smooth and flash-free, require a minimum of machining before assembly into your product.

Come to RITCO for drop forgings, special fasteners, and finished bolts with regular or heavy heads. We also offer complete facilities for finishing—machining and grinding. Estimates gladly submitted. Rhode Island Tool Company, 148 West River Street, Providence 1, Rhode Island.

RITCO

EXCLUSIVE NEW ENGLAND REPRESENTATIVES FOR CLEVELAND CAP SCREWS

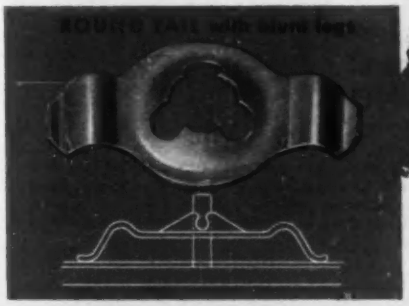
★ SERVING AMERICAN INDUSTRY SINCE 1834 ★

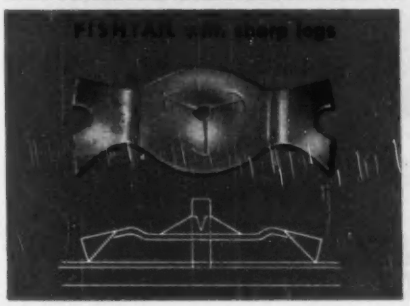
Fishtail...

New anti-rattle fastener for NAMEPLATES and trim holds threadless studs

Quick, tight, permanent fastening for name-plates and other die-cast trim is now possible without nuts and washers, thanks to United-Carr's Fishtail fastener.

Easily attached with simple hand tools, its teeth actually bite into chrome-finished, threadless studs so that there is no chance of slippage or looseness.





Fishtail's grip on welded, staked or extruded studs is independent of the pressure of the spring take-up legs. Leg pressure, however, allows positioning adjustments while it provides secure anchorage even when the studs protrude through oversize holes.

Fishtail fasteners can be used on flat or contoured surfaces and their cup-shaped centers hold and retain sealing compounds.

Like thousands of other fasteners and allied devices, designed and manufactured by United-Carr, Fishtail fasteners help speed assembly and cut costs. Available in a complete range of sizes and in volume quantities; further details on request.

UNITED-CARR

MAKERS OF DOT FASTENERS

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS

SUB-MINIATURE
PILOT LIGHTS
Approved for AIRCRAFT
AND IMPROVED IN IMPORTANT DETAILS

DIALCO

A great aid to your miniaturization program

SUB-MINIATURE INDICATOR ASSEMBLIES

MOUNT IN 15/32" HOLE
ALL LENS COLORS

Easy lamp replacement with any midget flanged base lamp types

Complete blackout or semi-blackout dimmer types

ACTUAL SIZE
NON-DIMMING
No. 5-1930-621

ACTUAL SIZE
MECHANICAL DIMMER
No. 11-1930-621

THESE ASSEMBLIES LOGICALLY REPLACE LAMPS NO. 319, 320, and 321

PLASTIC PLATE (EDGE) LIGHT ASSEMBLIES

AIR FORCE and BUREAU of AERONAUTICS
MIL-L-7806 DRAWING MS-25010

DIALCO *No. TT-51* (Red filter-black top) or, *No. TT-51A*, complete with No. 327 Lamp

ALSO MADE
with other filter colors and with *light-emitting top* (for indication)

ALL OF THE ASSEMBLIES ILLUSTRATED ACCOMMODATE LAMPS NOS. 327, 328, 330, and 331.

ANY ASSEMBLY AVAILABLE COMPLETE WITH LAMP

SAMPLES ON REQUEST — NO CHARGE

Foremost Manufacturer of Pilot Lights
DIALIGHT CORPORATION
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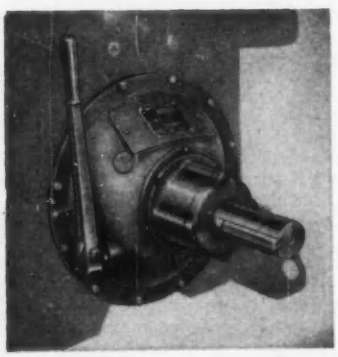
FUNK
POWER TAKE-OFFS
and
GEAR REDUCTION POWER TAKE-OFFS
For Industry & Agriculture



. . . are available with over-center clutches for all engines with SAE flywheel housings. Gear reduction units feature exclusive straddle mounted pinions; special ratios and special adaptations of standard units. Immediate delivery. Write for catalog and prices.

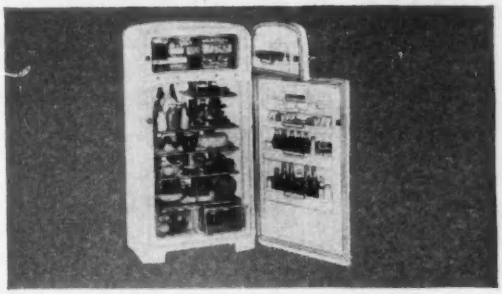
Special gear reduction with two shafts, one turning same speed and rotation as engine, the other anti-enginewise at optional reduction.

Funk Products Include:

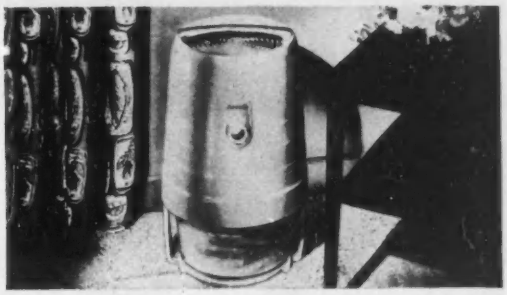
Right Angle Take-Offs.
Front End Take-Offs.
Jack Shaft Extensions.
Ford Tractor Conversion Kit changes to 6 or V-8 engine, doubles power and uses.

FUNK AIRCRAFT CO.
3301 Airport Drive Coffeyville, Kan.

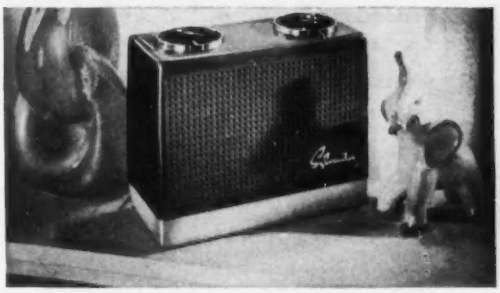
Polystyrenes you helped to create in '53



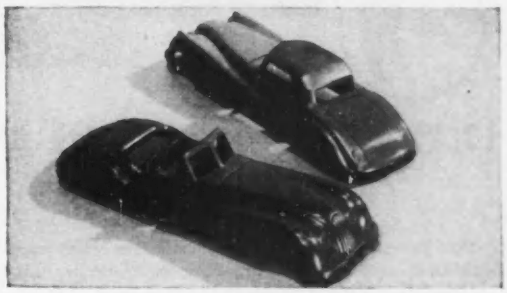
You needed a plastic with high impact resistance and easy flow in molding for refrigerator door liners. Koppers Modified Polystyrene MC-305 was developed to solve your problem.



You needed a plastic with high impact, high heat resistance, fast setting, and an excellent finish for moisture conditioner housings. Your demand was answered with Koppers Modified Polystyrene MC-309.



You needed a medium impact, high heat-resistant plastic with high lustre . . . for radio cabinets where breakage and scuffing on ejection presented a reject problem. Koppers Modified Polystyrene MC-409 had the exact characteristics to do the job.



You needed a plastic with impact resistance, toughness, easy moldability, economy and ability to reproduce engineering details in toys. Koppers engineers recommended Modified Polystyrene MC-405 to fill these requirements.

KOPPERS POLYSTYRENES

Type 3	General Purpose Polystyrene
Type 7	Improved Heat Distortion Temperature
Type 8	Highest Heat Distortion Temperature
MC-185	High Impact, Lowest Water Absorption Rate
MC-301	High Impact, Improved Heat Distortion Temp.
MC-305	High Impact, Easy Flow
MC-309	High Impact, Highest Heat Distortion Temp.
MC-401	Medium Impact, Improved Heat Distortion Temperature
MC-405	Medium Impact, Easy Flow
MC-409	Medium Impact, Highest Heat Distortion Temp.

• Here are four success stories about Koppers Polystyrenes. Each application presented its own special problem, and in each case a Koppers Modified Polystyrene was created to meet these special requirements.

The best polystyrene for you is the one that embodies the very qualities required to make your product more serviceable and more attractive. That's why the family of Koppers Modified Polystyrenes is constantly growing, at your request, to meet your needs.

Why not contact a Koppers representative for more information about the wide range of Koppers Regular and Modified Polystyrenes? They are anxious to help you select the exact polystyrene that will improve your product and lower your production costs.

Koppers Plastics Make Many Products Better and Many Better Products Possible.

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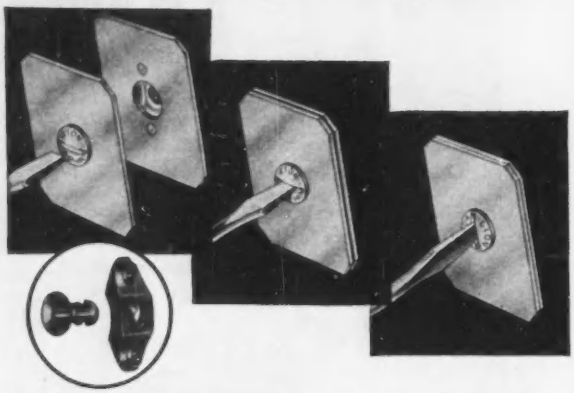
For Parts that must be
TAKEN OFF–PUT BACK–BUTTONED TIGHT

LION FASTENERS



LOCKS TIGHT WITH A QUARTER TURN
Always at correct tension

Lion Fasteners are *right* for buttoning parts that must be removed repeatedly for inspection, maintenance, or other reasons.

Vibration and shock can't loosen a Lion Fastener. Even an inexperienced service man can't replace it wrong. A quarter turn opens it. Another quarter turn locks it. The tension is *designed into it.*

Lion Fastener Spring Assembly is quickly spot welded or riveted in place. The stud cannot be lost. It is grommeted tight to the sheet. They will button sheets .040 plus or .020 minus over or under standard rating. The misalignment is as much as .156. The one-piece forged stud is tested to 1425 lbs. Write today for demonstration kit and application data.

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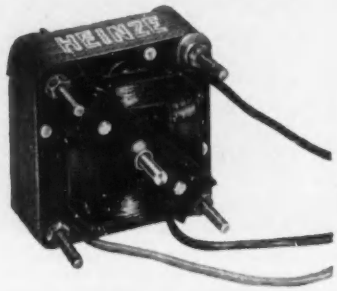

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75mf. capacitor.

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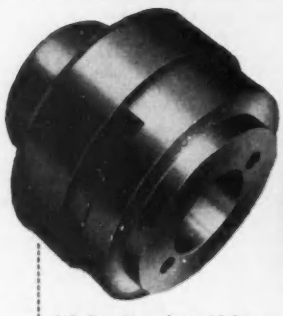

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CIF Coupling: 1 to 64 hp. at 100 rpm . . . max. bore 1⅝ to 5⅞.

★**COMPACT—fits right into the flywheel . . . saves space required by conventional hub length**

★**ECONOMICAL—elimination of one flange affords cost saving over standard flywheel couplings**

★**MAINTENANCE FREE—cushions changed without shutdown . . . . no lubrication required**

LOVEJOY Flexible Couplings provide maximum alignment correction, extra-smooth power transmission . . . absorb vibration, starting torque and shock of intermittent loads . . . assure optimum motor and machine performance. Cushions are made of materials best suited to load conditions.

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Conversion of this agricultural machinery hitch from a weldment—produced from five pieces of steel—to a one piece steel casting effected a savings in cost of 17%.

As a result of close cooperation between manufacturer's engineering department and the steel foundry, weight was also reduced—from 9.3 pounds to 6.3 pounds; a savings of 32%.

Cored holes in the steel casting eliminated drilling four holes . . . better appearance of this part as a steel casting helped give the overall product more eye appeal.

* * *

Here is another example of the foundry cooperation which is resulting in lower costs and improved products through redesign to steel castings.

This service is offered without cost or obligation. It makes available through your foundry representative the full results of the development and research program carried on by the Steel Founders' Society of America.

Product Development Contest . . .

Two awards of $1000 each and four other cash awards—a total of $3500. Entries to be new ideas or applications of steel castings, and case histories of new jobs put into production. Write for folder giving full information.

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STEEL FOUNDERS' SOCIETY OF AMERICA

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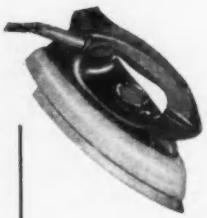
Design and Build With Steel Castings

A PECO 5c DIE CASTER

'ironed out' the production problems

of this sole plate



These sole plates are being produced by the BRITISH DIE-CASTING CO. for MORPHY-RICHARDS, LTD. The main illustration is of the production of these castings completely carried out on the PECO 5c Die-Caster.

PECO machines have completely modernized the technique of Cold Chamber Pressure Die-Casting and with their unique feature, an electrical control, they are considerably in advance of other machines on the market. Four core-pulling connections, hydraulic ejection cylinder and bumper bars for mechanical ejection are fully interlocked, permitting operation in any sequence.

Illustrated literature on the 2c and 10c Die-Casting Machines will be gladly sent on request.

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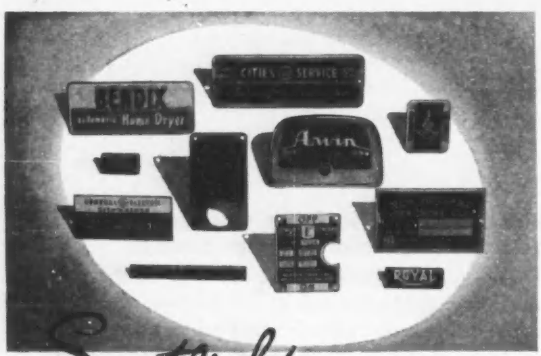

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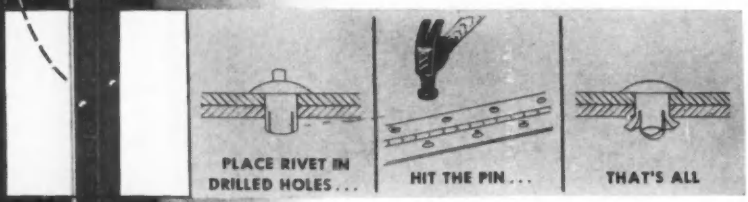

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. . . that's why Gates V-Belts Last Longer!

Typical Gates Vulco Rope Drive—the Gates V-Belts are built with Concave Sides to insure longer belt wear.

Look at this!

In *half a minute* you can prove for yourself the belt-saving advantage of the CONCAVE SIDES.

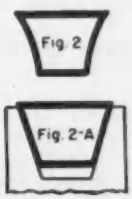
Take any *straight-sided* V-Belt (Fig. 1) and bend it as it bends in going around its pulley. At the same time, grip its sides with your fingers and *feel* those sides *bulge out* as in Fig. 1-A.

Clearly, those bulging sides will press *unevenly* against the V-pulley—and this causes extra wear at the points shown by the arrows (Fig 1-A).

Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2)

As the belt bends, grip its sides—and you will feel the precisely engineered CONCAVE SIDES *fill out* to an *exact fit* in the sheave groove (Fig. 2-A).

These sides press *evenly* against the V-pulley. All wear is distributed *uniformly* across the full width of the Gates Vulco Rope—and this means *longer* belt life and *lower* belt costs for you!



When you buy V-Belts, be sure to get the V-Belt with the CONCAVE SIDES— The Gates Vulco Rope.

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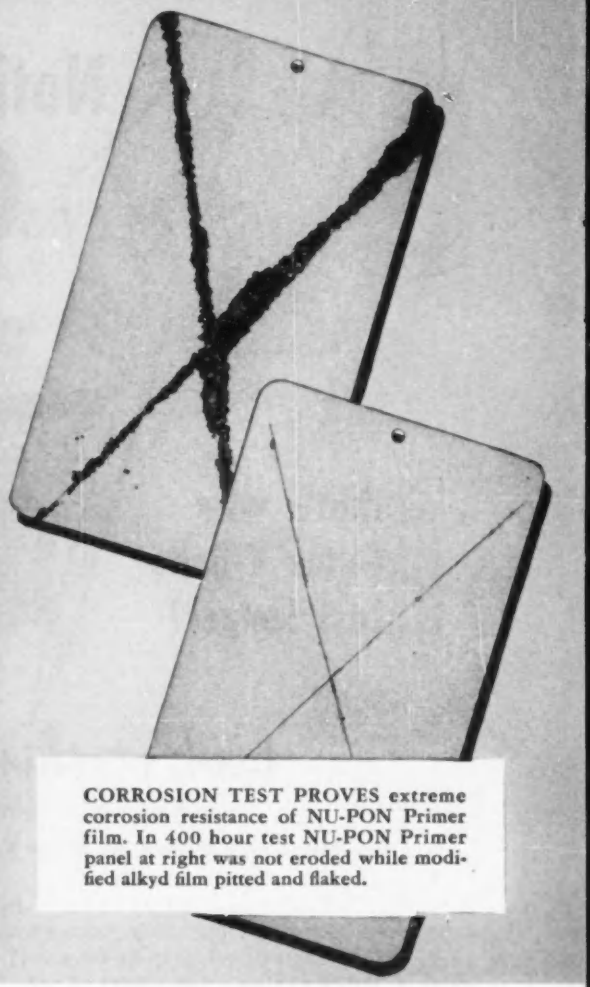

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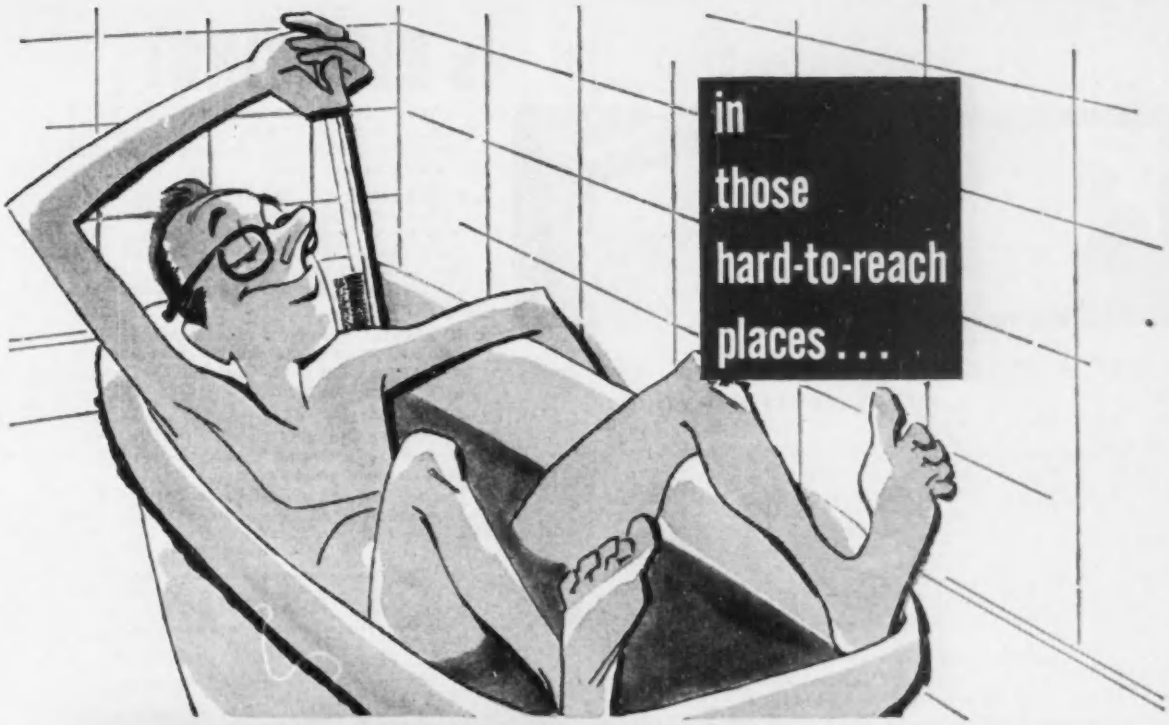
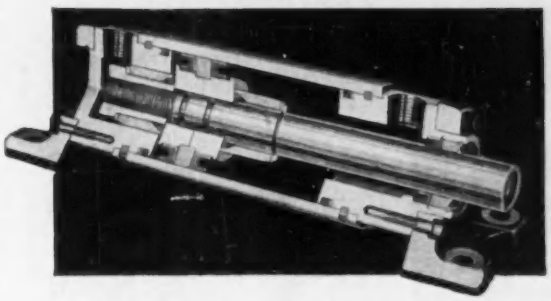


in those hard-to-reach places . . .



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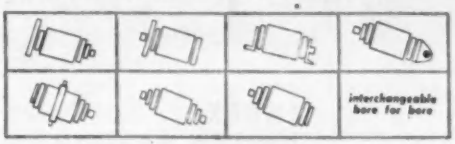

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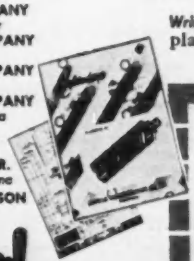

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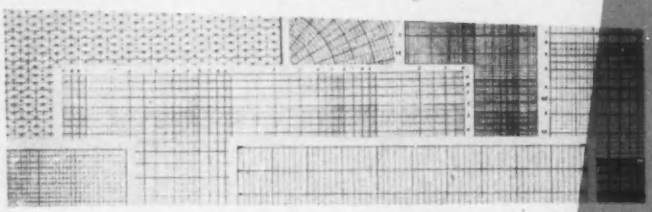

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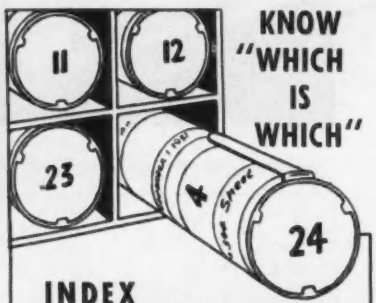

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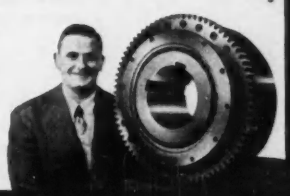

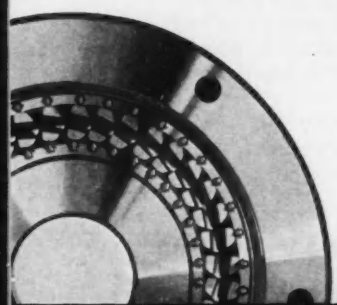

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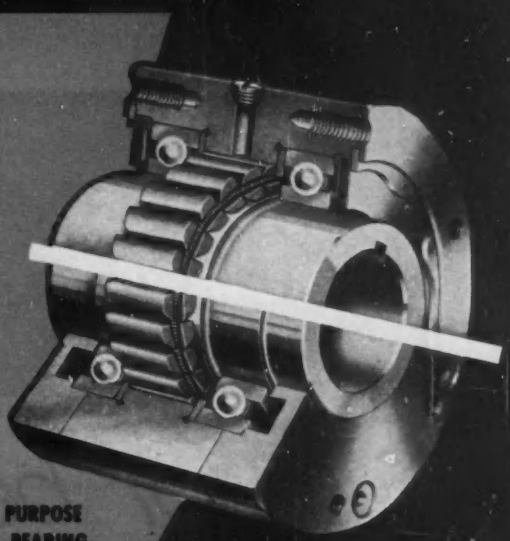

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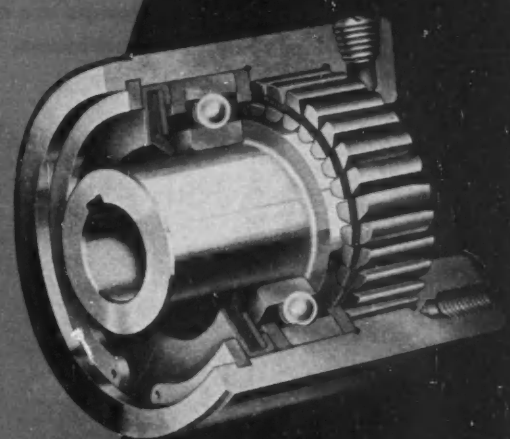

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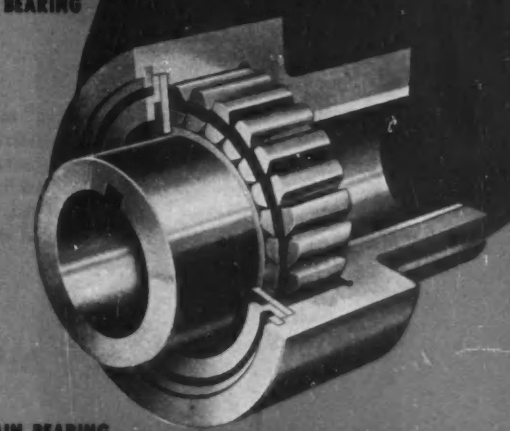

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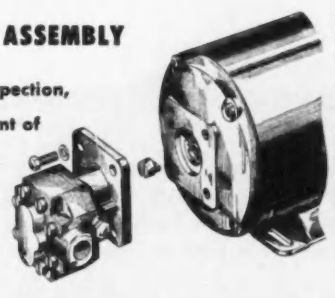
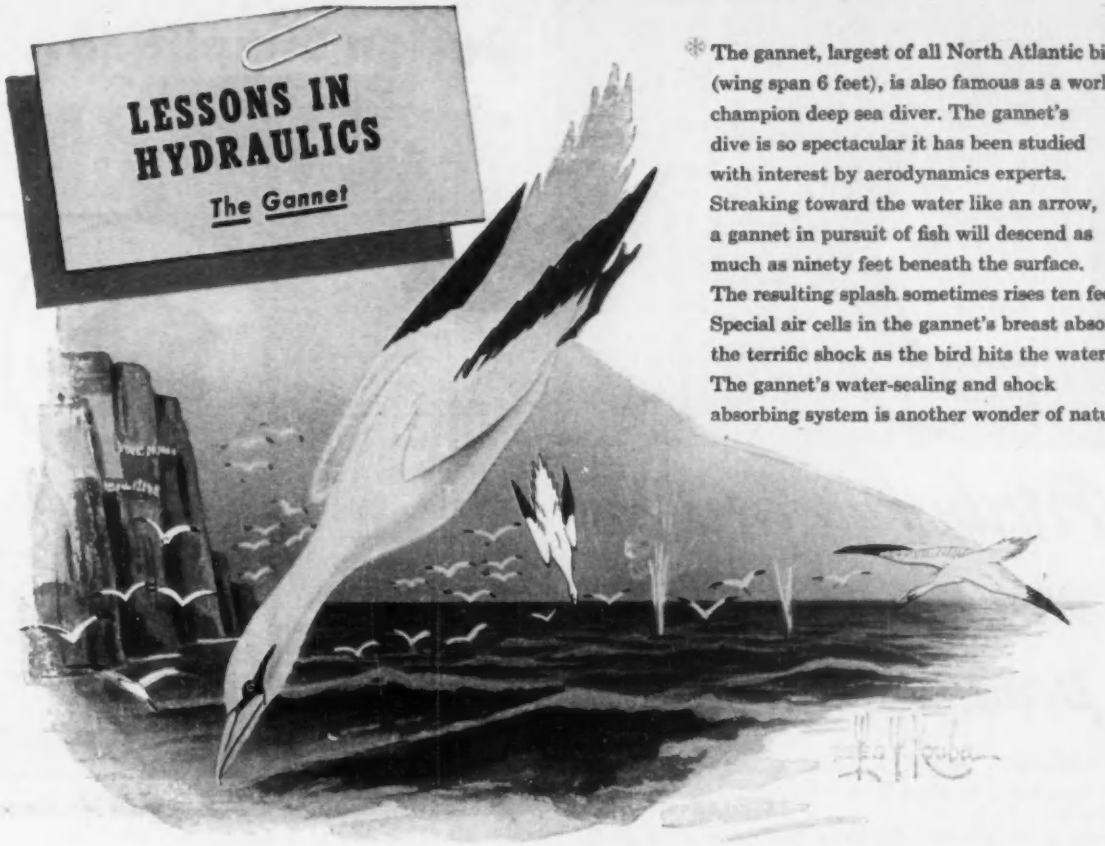
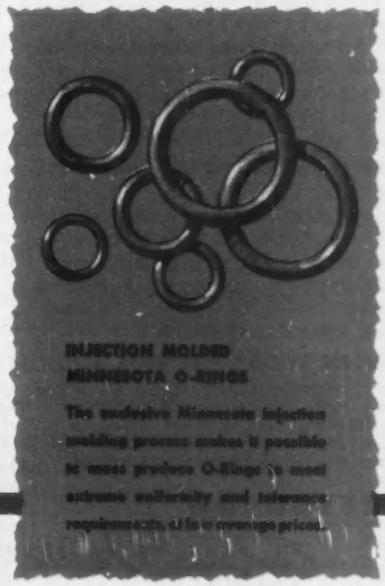




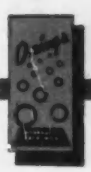
* The gannet, largest of all North Atlantic birds (wing span 6 feet), is also famous as a world champion deep sea diver. The gannet's dive is so spectacular it has been studied with interest by aerodynamics experts. Streaking toward the water like an arrow, a gannet in pursuit of fish will descend as much as ninety feet beneath the surface. The resulting splash sometimes rises ten feet. Special air cells in the gannet's breast absorb the terrific shock as the bird hits the water. The gannet's water-sealing and shock absorbing system is another wonder of nature.

THE BIRD WITH SHOCK PROTECTION

Minnesota O-Rings are "doughnut shaped" packings used as shaft seals in air, gas or hydraulic systems. Every day, leading product engineers are proving the dependability and wide application of O-Rings by discovering new uses for these unique seals. Minnesota O-Rings are made from special compounds of natural or synthetic rubber to meet exacting product specifications for close tolerances and uniform quality. Hundreds of successful installations have been designed into such equipment as hydraulic rams and regulating valves . . . remote control mechanisms . . . air cylinders . . . water pumps . . . gasoline and steam engines. For prompt analysis and quotation on your next packing installation, send us your blueprints or specifications.



* *The many advantages and applications of injection molded O-Rings merit your investigation. Bulletin available on request.*



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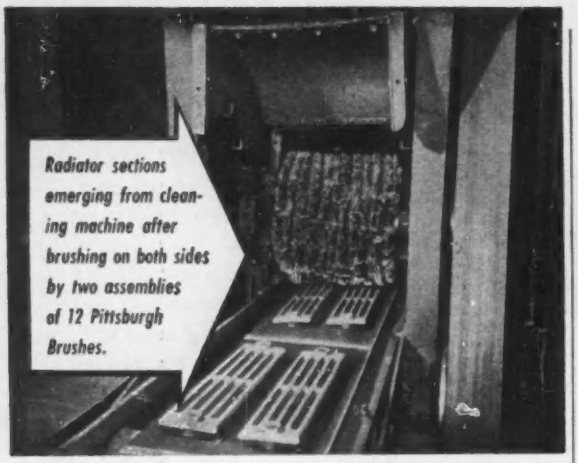

Radiator sections emerging from cleaning machine after brushing on both sides by two assemblies of 12 Pittsburgh Brushes.

Pittsburgh Brushes can help you solve problems like these!

Cleaning Narrow Spaces—National Radiator Company, Johnstown, Pa., cleans 30,000 radiator sections a week! To insure a perfect final finish, even the narrowest spaces must be absolutely clean prior to assembly. Pittsburgh engineers were asked to design a brush that would reach these spaces and would fit National's existing machine. Successful? National reports: "Pittsburgh Brushes do a better job of cleaning and are more economical!"

Preparing Chills—At Continental Foundry & Machine Co., East Chicago, Indiana, chills used to cast iron rolls must be cleaned of the oxidized metal remaining from previous usage, as well as dirt and grease accumulated in storage. After experimenting with other brushes, Continental chose Pittsburgh because they "do the job better and stand up longer than any previously used!"

Improving Original Equipment—The Sommer and Maca Glass Machinery Co., Chicago, Illinois, uses Pittsburgh Brushes in the automatic washing machines they manufacture. Brushes formerly used simply didn't have the over-all density pattern needed. Pittsburgh engineers studied the problem and designed a brush which Sommer and Maca approved "because of (its) denser bristle pattern and lower cost."

WRITE TODAY FOR FREE BOOKLET!

Write today for a free copy of our booklet that shows, through actual case histories, how Pittsburgh cuts brushing costs. Address: PITTSBURGH PLATE GLASS COMPANY, *Brush Div.*, Dept. W-6, 3221 Frederick Ave., Baltimore 29, Maryland.

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Model 3 B lever type control

Design engineers at Century Geophysical Corporation make use of the Metron Variable Speed Changer to give them continuously adjustable chart speeds in their miniature oscillograph.

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Metron Variable Speed Changers are designed into countless products that call for changes in speed. The units are small—only 4 3/16" long—to fit minimum space. They are smooth and accurate in operation and cover infinitely variable output speeds from 5:1 step down thru 1:1 to 1:5 step up.

- For further information about how Metron units can simplify your costly speed changing problems, write for Bulletin 99.

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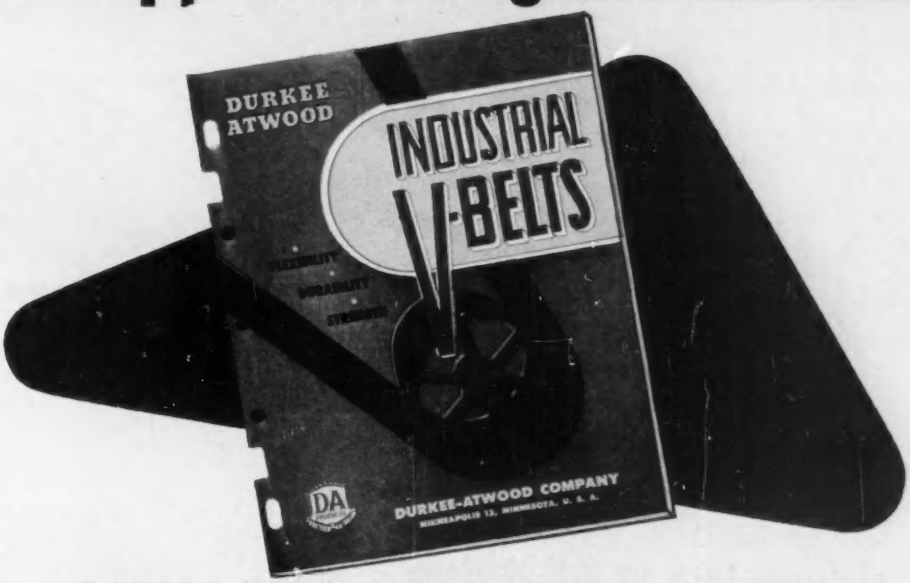

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By using higher ratings in the popular speed ranges, in many cases fewer belts and fewer sheave grooves can result in lower costs. Adequate safety margins are still included.

Durkee-Atwood offers you the first Industrial V-belt catalog published with new increased horsepower ratings approved by the Rubber Manufacturers' Association. Technical information includes:

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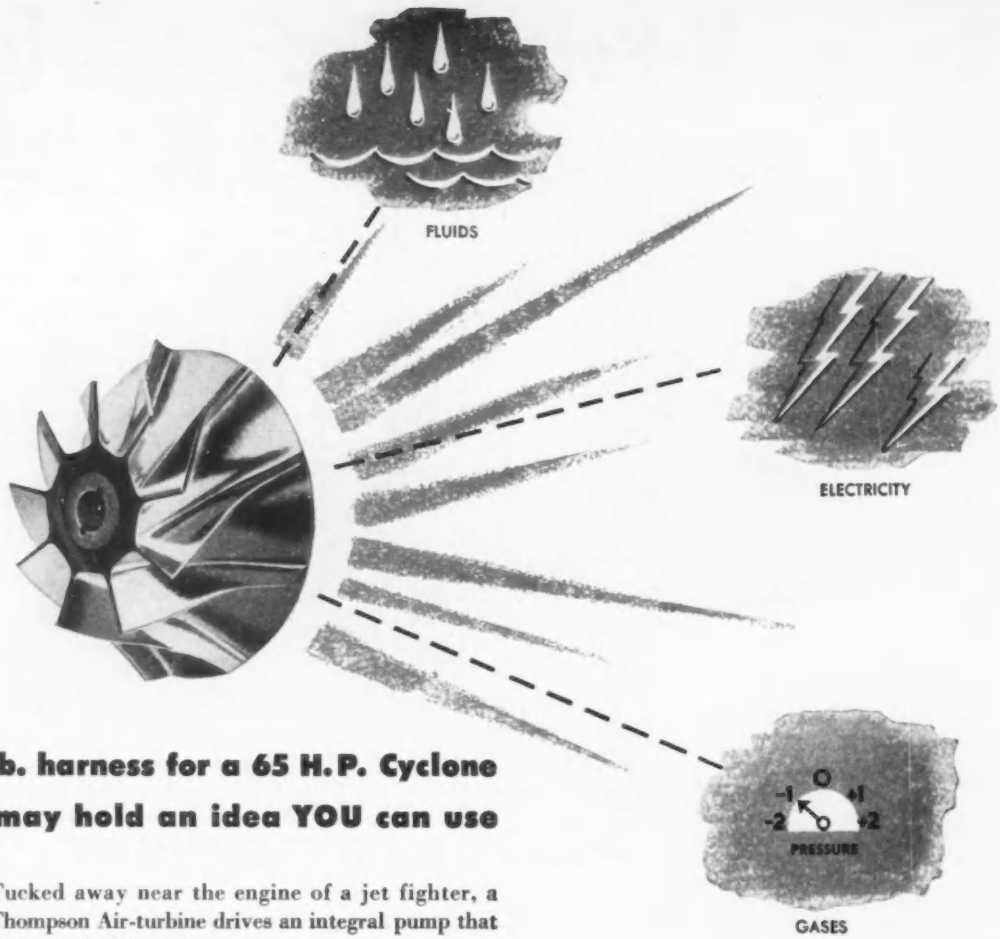
FOR YOUR FREE COPY CATALOG D161A WRITE DEPT. PE-12, Durkee-Atwood Co., Minneapolis 13, Minn. Separate catalog information also is available on Durkee-Atwood Industrial V-sheaves, Light Duty type Catalog D172 and QD type, Catalog D170.

DURKEE ATWOOD **DURKEE-ATWOOD CO.**



This 12 lb. harness for a 65 H.P. Cyclone ...may hold an idea YOU can use

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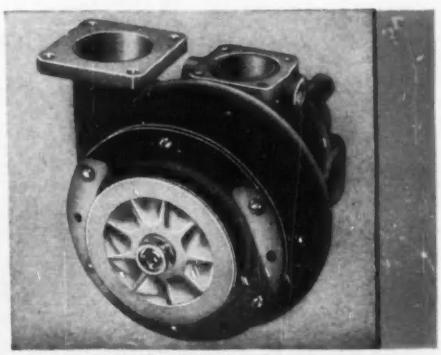

12-pound, 65-HP Air-Turbine-driven Pump

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IN HOT OIL

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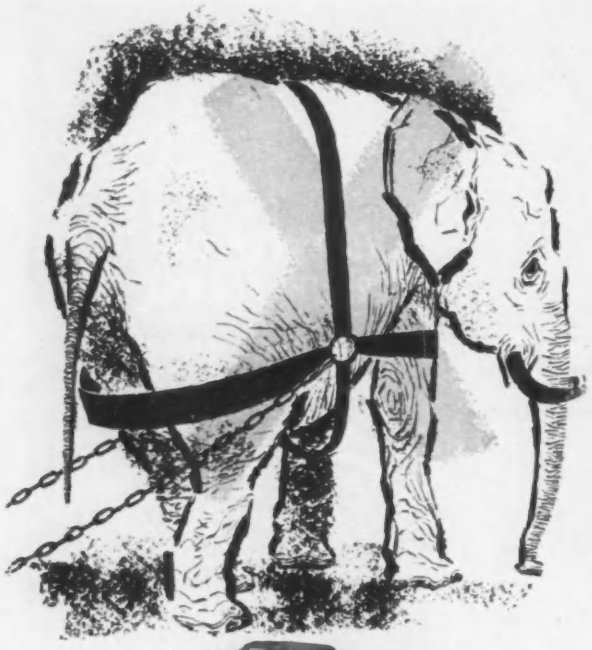

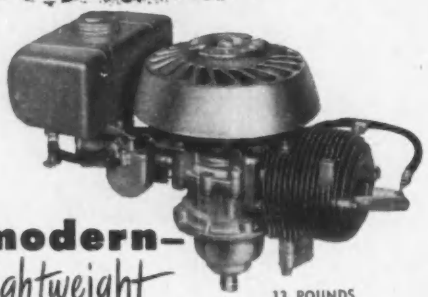

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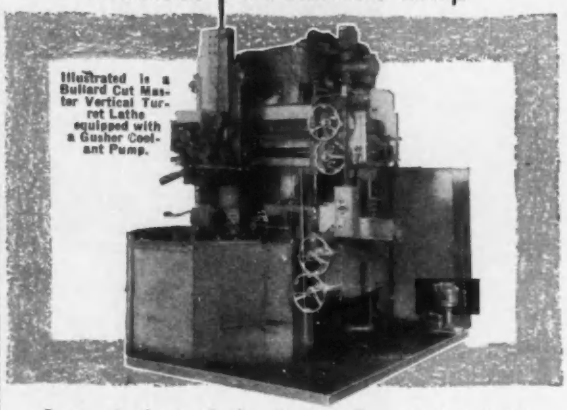

Illustrated is a Bullard Cut Master Vertical Turret Lathe equipped with a Gusher Coolant Pump.

Once a Ruthman Gusher Coolant Pump is installed it requires little or no attention. The pre-lubricated heavy-duty ball-bearings require no further lubrication, there are no packing glands to adjust. The dynamically balanced rotating shaft minimizes vibration and wear. Minimum power is consumed when the Gusher is throttled down. You are sure of low cost operation when you specify Gusher Pumps on your machine.

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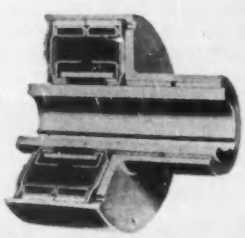

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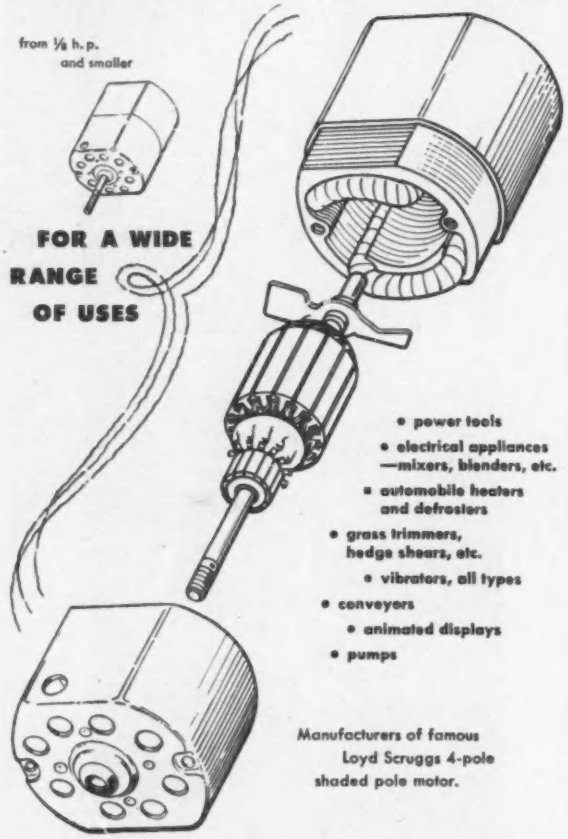
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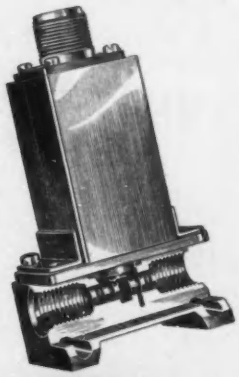

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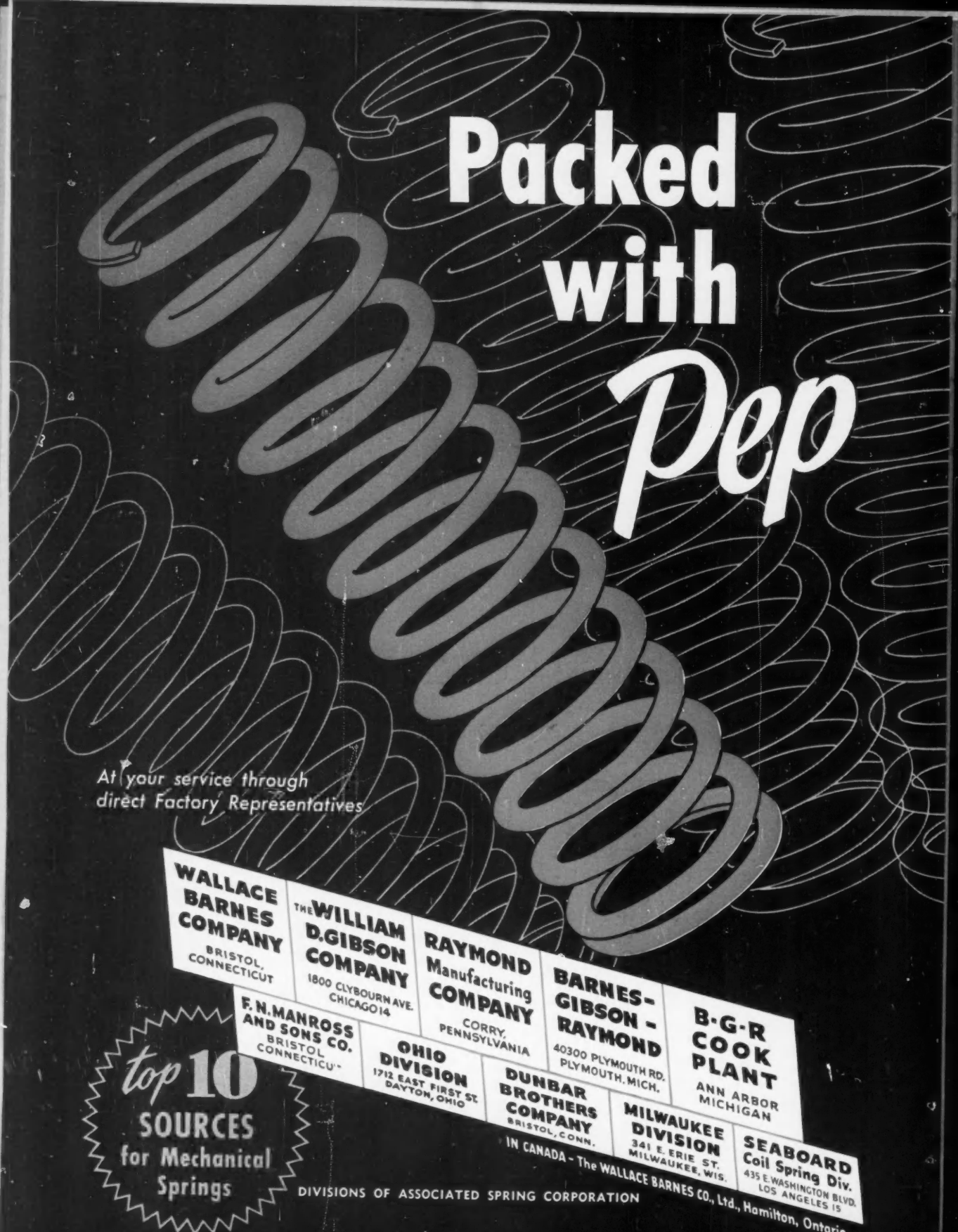
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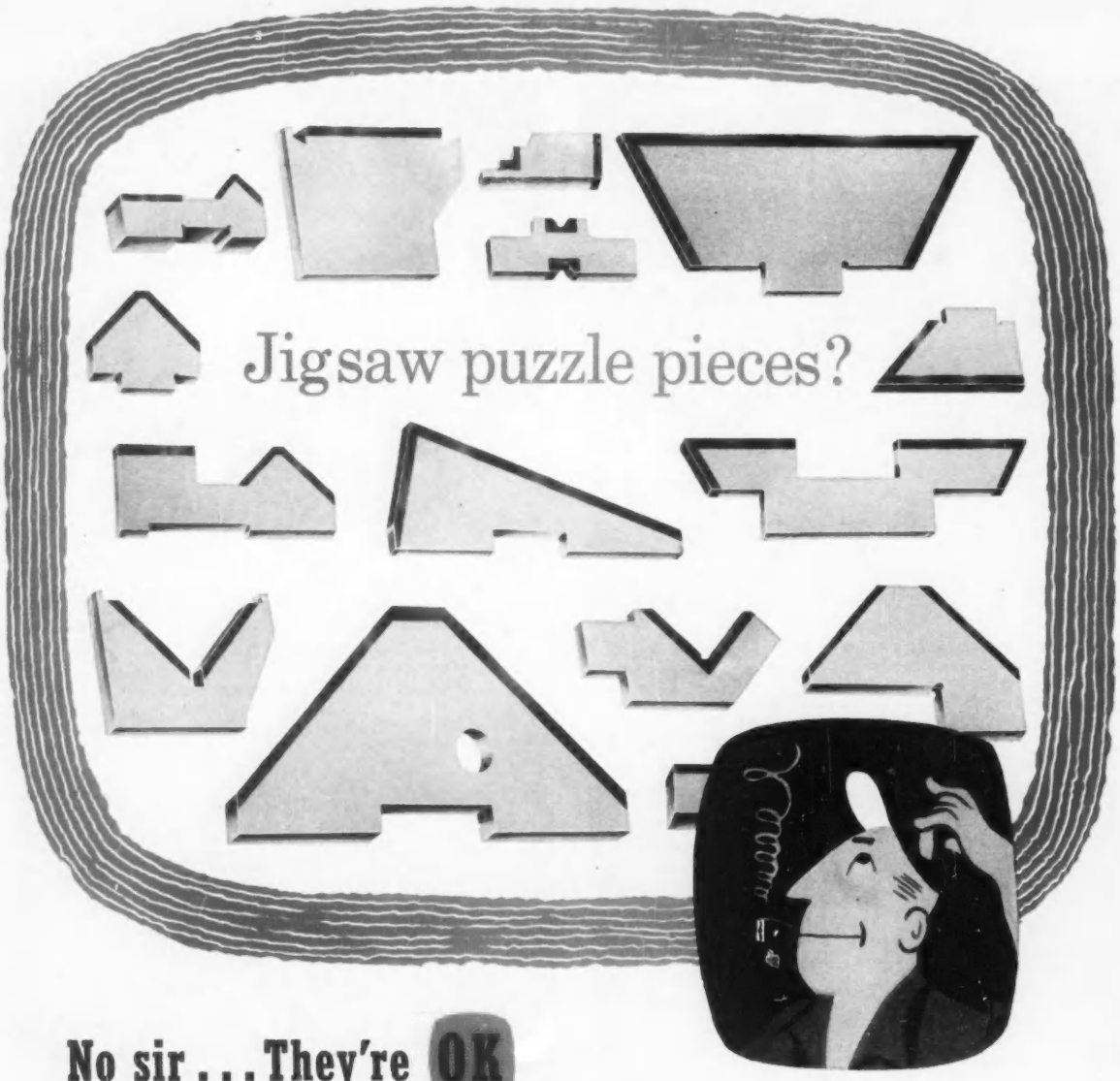

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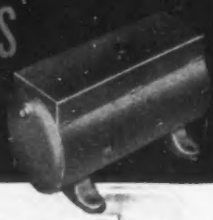
OTHER BREEZE PRECISION PRODUCTS Special Connectors
Actuators • Ignition Shielding • Aero-Seal Worm Drive Hose Clamps

From any angle

SCAIFE PRESSURE VESSELS

are your best buy



Take air compressor tanks for example:

COST Modern equipment and advanced production techniques provide Scaife Company customers with quality pressure vessels at the *right* price . . . a price that helps you hold down the cost of the equipment you manufacture.

EFFICIENCY Scaife engineering skill and ingenuity plus continuous research are available to work for you in supplying the most efficient pressure vessel for your application . . . a vessel from Scaife's broad line of standard units that fits exactly the operating standards of the equipment you manufacture.

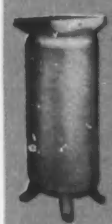
UNIFORMITY Rigid quality control practices are carried on throughout every step in the manufacture of Scaife pressure vessels. The result—volume production of uniform, quality cylinders and tanks precisely to the customer's specification.

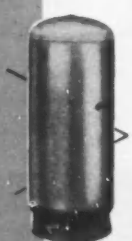
DEPENDABILITY A history of more than 150 years of continuous operation provides evidence that Scaife Company has proved itself a dependable source of supply.

Whether you require ASME Code, ICC, other code or non-code pressure vessels, for air, water or gases, Scaife Company is qualified to serve you. Send for more complete information on Scaife Pressure Vessels today.

Typical Uses For Scaife Pressure Vessels

Tanks for Air Compressors
Tanks for Railroad Cars
Tanks for Water Heaters
Diesel Engine Starting Tanks
Tanks for Pneumatic Control Systems
Hydro-Pneumatic Tanks for Well Pump Systems
Domestic Water Purification Tanks
Gas Cylinders and Tanks (ICC and ASME)
Tanks for the Plumbing Industry





FOUNDED 1902

SCAIFE COMPANY

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MAKERS OF PRESSURE VESSELS AND DRAWN SHAPES

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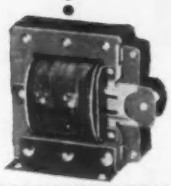
SOLENOIDS and COILS

OUTLAST Equipment life!



Precision engineered from the finest quality materials by specialists with more than 30 years experience . . . Dormeyer solenoids assure you the smooth-operating, dependable service that you need in your equipment. All types available —custom-made to your particular requirements.

Dormeyer Coils are precision-wound, quality controlled and can be produced in any quantity to your specifications. Available for every electrical purpose, including fine wire coils up to No. 50 wire.

Write for catalog . . . send specifications for free estimate

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This Special Editorial Report covers classes and types of electrolytic and chemical coatings . . . how base metal affects selection . . . appearance and protective finishes . . . new development and industry trends . . . and examples showing how your products will look. Included is a comprehensive chart analysis of all types of organic, inorganic, and specialty finishes for the major metals.

Copies of other reports in *Product Engineering's* series of full-color articles covering product improvement through better surface appearance and protection are also available. Write for an editorial reprint order form, listing titles and costs.

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ANACONDA® METALS AT WORK

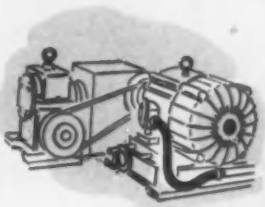
Copper "package" for the coldest products on earth

This container for storing and transporting liquefied helium (—452 F.) or hydrogen (—421 F.) is made by Superior Air Products Co. of Newark, N. J. The secret of keeping heat out to reduce evaporation is four concentric copper spheres separated by a high-vacuum space, a nitrogen protecting bath, and a second high-vacuum space — the entire unit enclosed in a stainless steel casing. Copper contributes ductility and malleability for spinning into hemispheres, unexcelled soldering properties for joining into spheres, and a mirror finish to reduce radiation losses. Need we tell you that it's made of ANACONDA Copper?

This "iron horse" runs on brass

The "High Iron" we're referring to is the HOBBYLINE HO-GAGE model railroad track which John A. English & Co. of Morrisville, Pa., makes of FORMBRITE** strip. This fine-grain, yet ductile forming brass produces a track so strong and stiff it will support an adult's weight. In products where finishing costs count, users find that FORMBRITE usually needs only a color buff to produce a high finish.

Flexible conduit enjoys a splash in a bath



The real trick is to make an electrical conduit that's flexible *and* liquid-tight *and* approved by Underwriters' Laboratories for such applications. SEALTITE* Type UA does all three. Made with a tough synthetic jacket extruded over a flexible steel core, it's shown here protecting wiring to motor in an auto laundry. It ignores not only splashing, but also oil and grease, and resists abrasion. Want more facts?

We put an end to "the bends"

We don't mean the kind deep-sea divers suffer from, but the kind heating contractors had to put up with when they installed radiant panel heating systems. Heretofore, many contractors formed the panel grids on the job by hand-bending them from coils of tubing—a time-consuming, laborious, back-breaking job. Now PG's** have ended all that. They are the new, compactly packaged, accurately *preformed* ANACONDA Copper Tube Panel Grids . . . from the handy carton to installation is only a matter of minutes. PG's are another ANACONDA first.

A service for you

Our Technical Department has a range of experience that covers the entire field of copper and copper-alloy applications in industry. If you have a problem of metal selection, we are at your service. *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

*Trademark
**Reg. U.S. Pat. Off. 3393

ANACONDA® *the name to remember in* **COPPER — BRASS — BRONZE**

Make Your Own Hose Lines

AEROQUIP HOSE AND FITTINGS ARE MATCHED FOR GUARANTEED PERFORMANCE

● No skill or special training is required to assemble Aeroquip Flexible Hose Lines by hand *in a matter of minutes!* YOU CUT COSTS because Aeroquip fittings are detachable and may be used again and again. YOU REDUCE INVENTORY because with Aeroquip bulk hose and a few fittings you can fill practically all your hose line requirements. YOU REDUCE DOWNTIME because with Aeroquip on hand, quick hose line replacements are available at all times.

Cut hose to length with hacksaw; screw into socket.

Oil nipple and inside of hose liberally.

Screw nipple into socket and hose.

Install fitting on other end; hose line is ready for use.

Aeroquip

REG. TRADE MARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

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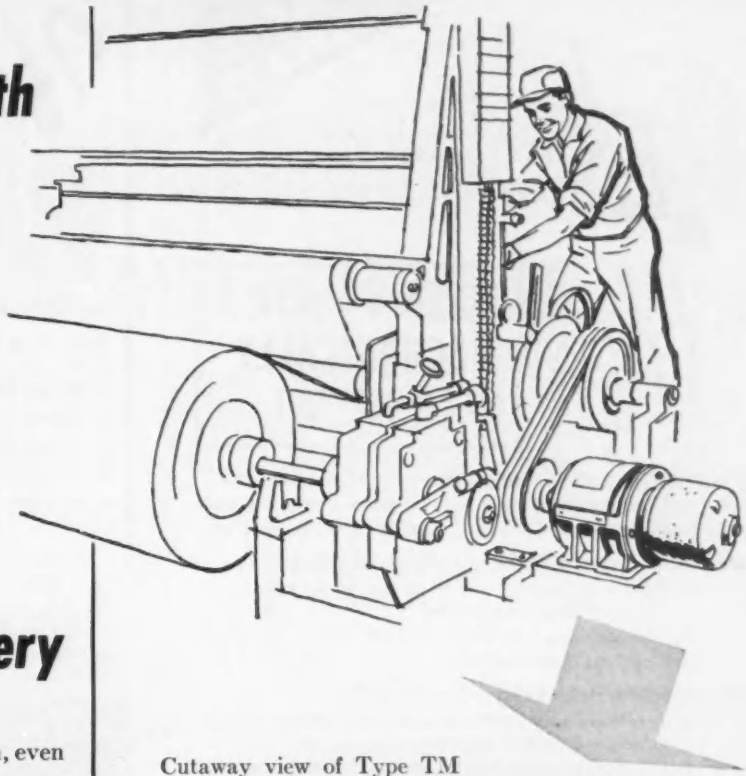
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Save 4 ways with

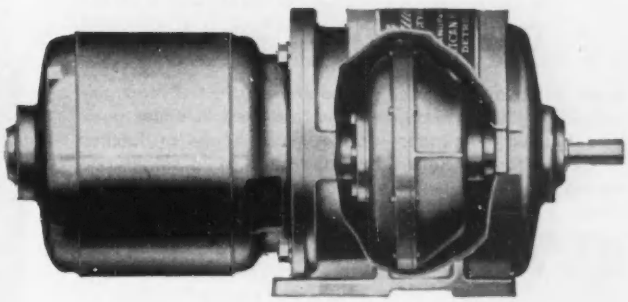
GÝROL FLUID DRIVES

on paper machinery



1. Gýrol Fluid Drives provide smooth, even starting to prevent tearing of paper. **2.** No-load starting keeps power needs low, even with constant stop-and-go operation. **3.** The complete simplicity of the Fluid Drive-squirrel cage motor combination offers a dependable drive — essential for uninterrupted paper production. **4.** Fluid Drive's cushioning effect makes the job easier for motor, gears, belts and other drive components — makes equipment last longer.

Cutaway view of Type TM Gýrol Fluid Drive unit



Advantages of American Blower Type TM Gýrol Fluid Drive

- Provides smooth flow of power. Shocks are absorbed in a cushion of oil. There's no metal-to-metal contact between driving and driven machinery.
- Offers by its inherent shearpin action, selective overload protection for both motor and driven machinery. Decreases machine "down" time.
- Available as a complete packaged unit suitable for either direct or belt connection to the driven machine. Minimizes alignment problems.

Free trial units are available to original equipment manufacturers

American Blower Corporation, Detroit 32, Mich.
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ASCO RELAYS

MAGNETICALLY HELD RELAY?

MECHANICALLY HELD RELAY?

WHEN TO USE A MECHANICALLY HELD RELAY!

We at ASCO manufacture a wide range of both Mechanically and Magnetically Held Relays. Accordingly, we can *impartially* recommend the best relay for your application.

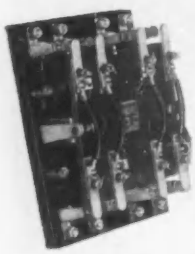
We Recommend a Mechanically Held Relay:

1. If the relay must "stay put" on loss of line voltage, or under low voltage conditions.
2. If AC hum cannot be tolerated.
3. If coil loss is undesirable.

Mechanically Held Relays Can Be Used:

1. As primary relay devices to control Contactors, Solenoid Valves, and similar equipment.
2. As branch circuit devices to control instrument processes.
3. For Automatic Control Systems to (a) maintain circuit control regardless of momentary interruptions in control line caused by low voltage conditions, or by associated relays; or (b) provide "memory circuits" and to permit preset control operations.

You'll want to use ASCO compactly constructed Mechanically Held Relays because they are locked in either position by sturdy linkages — no delicate hooks or latches to be damaged. Relays are operated by a single coil mechanism — positive in each direction.



AVAILABILITY:

10 AMPERES — Up to 12 poles normally open, and 12 poles normally closed.

25 AMPERES — Up to 6 poles normally open, and 6 poles normally closed.

OTHER RELAYS include control, power, voltage-frequency sensitive, latching, time delay, close differential, reverse current, special purpose, etc.

Many design engineers bring their Solenoid Valve and Electromagnetic Control problems to the widely experienced ASCO Engineering Staff. For, in dealing with ASCO, they can purchase both Solenoid Valves and Electromagnetic Control Panels from one *reliable* source.

ASCO Electro-Magnetic CONTROLS

May we send you complete information on our line of Mechanically Held Relays — also the Magnetically Held Designs?

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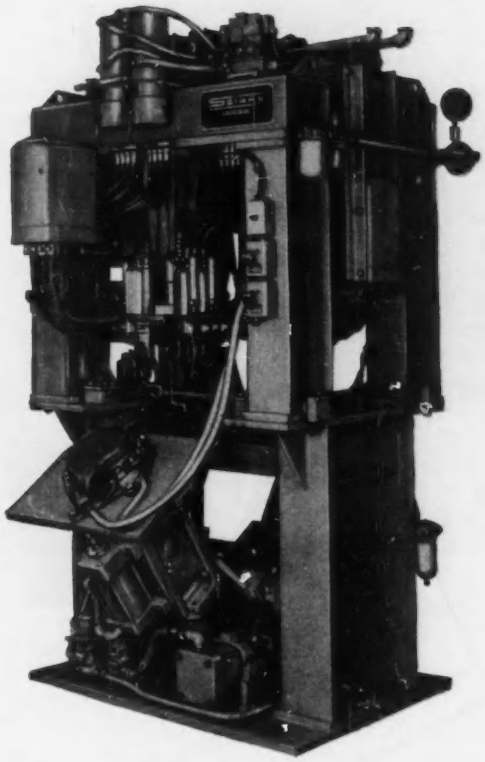
NEW
HIGH PRODUCTION WELDER
READILY ADAPTABLE TO
PRODUCTION CHANGES



The Sciaky Standard SX Electric Resistance Welder equipped as a 36 Gun Unit for welding blower housings at the rate of 500 per 50 minute hour.

New Sciaky Standard Multiple Gun Welder Designed for Wide Variety of Production Applications

High production, multiple gun applications no longer require uneconomical C-frame type electric resistance welding machines with special tooling, or complex, specially designed, one-job machines.

Now, Sciaky, pioneers and inventors of electric resistance welding machines, offers a standard multiple gun welder that can be readily adapted for production changes within the capacity of the machine.

The Sciaky SX Welder, a dual platen unit, mounts simple superstructure providing for different arrangements of standard transformer, booster, and welding electrode units.

With approved J. I. C. controls, and featuring either independent or simultaneous dual platen operation, the Sciaky SX Welder offers all the advantages of high production, precision welding, *plus* the tremendous economies of adaptability to production changes.

For complete information, write for Bulletin 4913.

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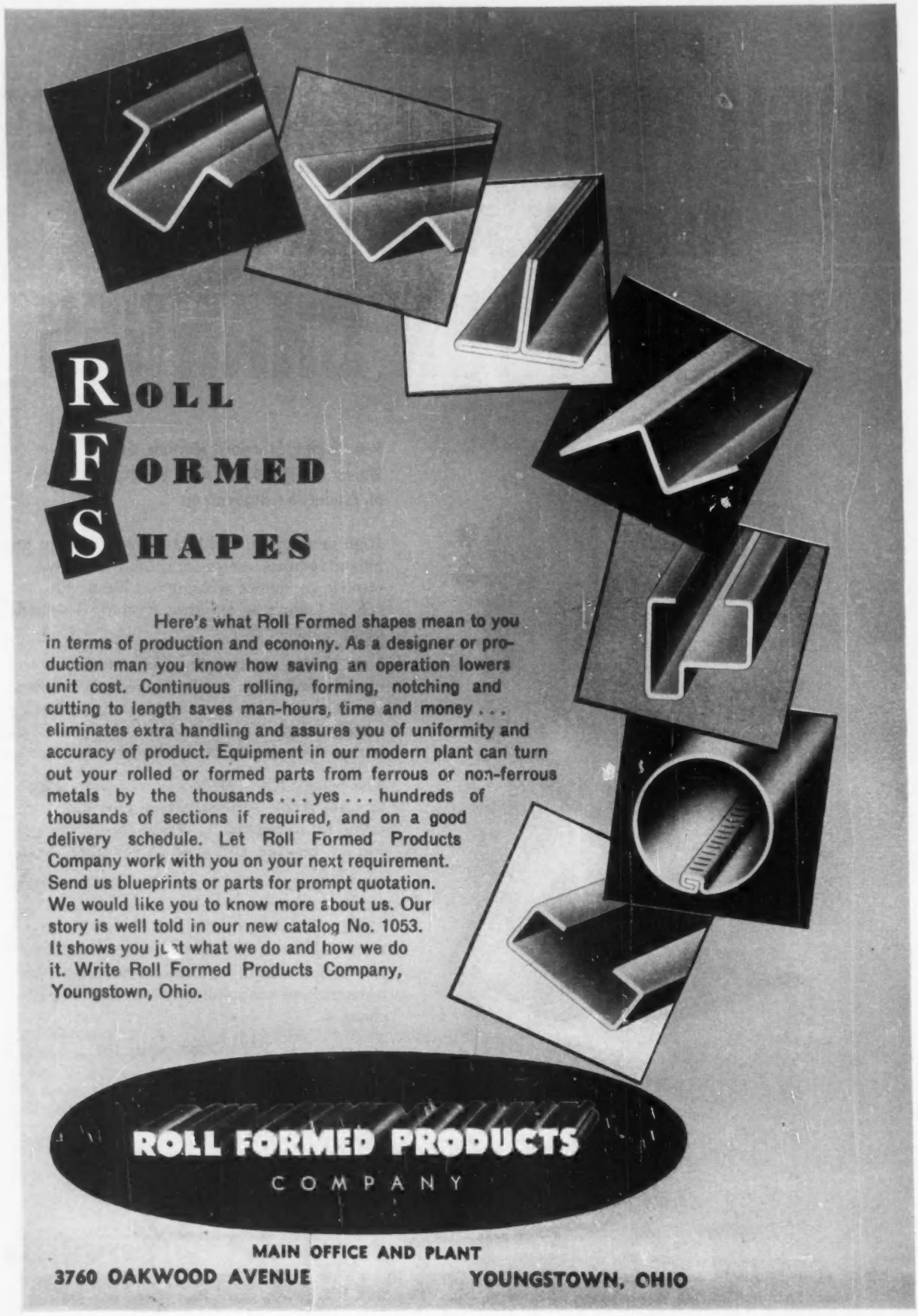

ROLL FORMED SHAPES

Here's what Roll Formed shapes mean to you in terms of production and economy. As a designer or production man you know how saving an operation lowers unit cost. Continuous rolling, forming, notching and cutting to length saves man-hours, time and money . . . eliminates extra handling and assures you of uniformity and accuracy of product. Equipment in our modern plant can turn out your rolled or formed parts from ferrous or non-ferrous metals by the thousands . . . yes . . . hundreds of thousands of sections if required, and on a good delivery schedule. Let Roll Formed Products Company work with you on your next requirement. Send us blueprints or parts for prompt quotation. We would like you to know more about us. Our story is well told in our new catalog No. 1053. It shows you just what we do and how we do it. Write Roll Formed Products Company, Youngstown, Ohio.

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COMPANY

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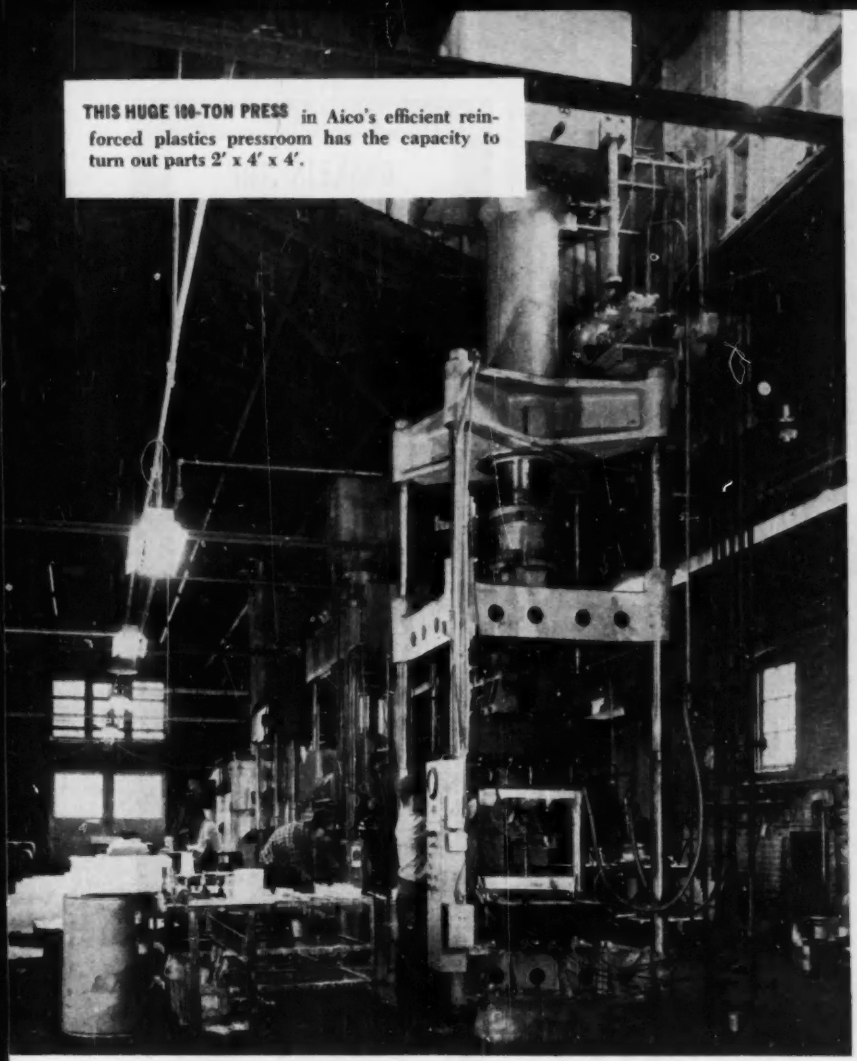
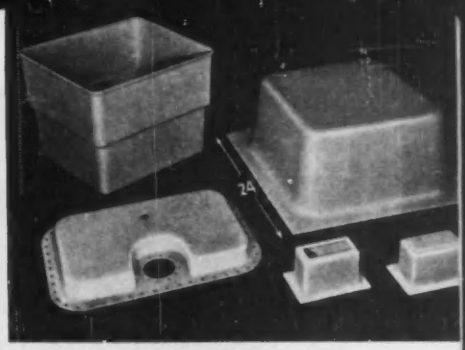
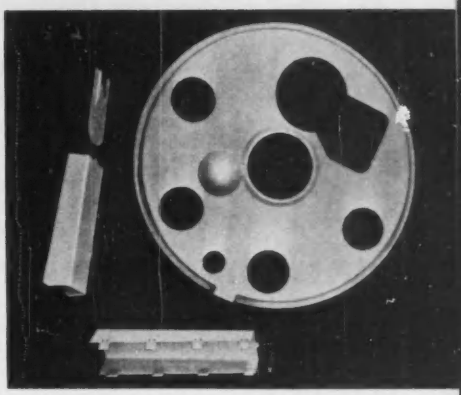


THIS HUGE 100-TON PRESS in Aico's efficient reinforced plastics pressroom has the capacity to turn out parts 2′ x 4′ x 4′.



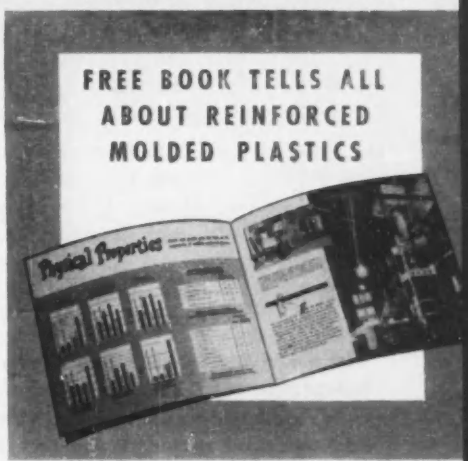
GLASS FIBER PREFORMS offer exceptional strength for tote boxes, trays and containers. Reinforced plastics were specified for the large 24″ form because of light weight and dimensional stability.



GLASS FIBER MAT MOLDINGS. Large circular piece is a cover for radar equipment. Complex shape required no hand work or punch press. This material offers ease of production, great strength plus transparency to electronic impulse.

AICO'S complete facilities for Molded Reinforced Plastics work to improve YOUR product

Aico . . . leader in the relatively new field of molded reinforced plastics . . . can play an important part in your production program. With complete facilities to do the entire job . . . from creative design and development to final delivery deadlines . . . Aico will lead the way to product improvement, quality refinement and reduced cost through the modern application of plastics. Many of America's leading manufacturers have benefited by the use of Aico molded reinforced plastics. Why not investigate the advantages it holds for you?



Tells what they are . . . gives physical properties . . . tells when to use Reinforced Plastics. Get the facts . . . find out how the advantages of Molded Reinforced Plastics apply to your products. Write for your free copy . . . today.

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these LITTLE DIFFERENCES mean

BIG ADVANTAGES when you specify

CAMBRIDGE INDUSTRIAL WIRE CLOTH

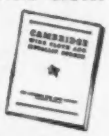
#1. Some manufacturers assign only one operator to as many as ten looms. But here at Cambridge, we have a specially trained operator for every single loom in the plant. Just a little difference . . . but a BIG advantage in accurate mesh count and constant screen width.

#2. Some wire cloth producers can work in only a certain few metals or in a limited range of mesh sizes. Here at Cambridge we can weave cloth from any metal that can be drawn into wire...our range of sizes runs from 20 x 250 mesh up to 4 inch openings ...a BIG advantage for customers with varied needs.

#3. Some manufacturers are not equipped to fabricate wire cloth into special forms, for example, filter leaves. But here at Cambridge, we can supply wire cloth in bulk or in practically any type of fabricated part . . . a BIG advantage that saves you time and money by providing one source for both weaving and fabrication.

These are just a few reasons why it will pay you to investigate Cambridge for your wire cloth needs. Call in your Cambridge Field Engineer to get the full story . . . and he'll gladly quote on your next order. Write direct or look under "Wire Cloth" in your classified telephone book.

FREE CATALOG! Gives full range of mesh sizes and types of cloth available from Cambridge, also valuable metallurgical data. Write for your copy today.



The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

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As gasket specialists we've solved many a tough problem.
Let us send you samples for testing in your own plant.

Ask for our Technical Data Book and samples for testing.

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* See our ad in 1954 Annual Handbook
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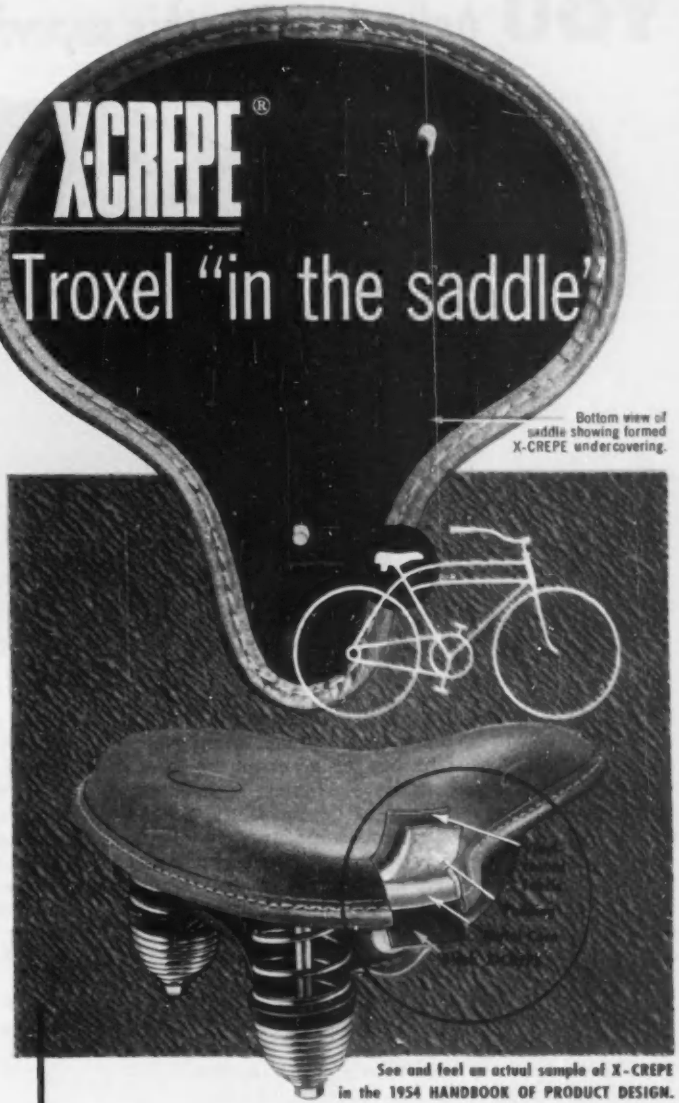
how Cindus X-CREPE® helps keep Troxel "in the saddle"



Bottom view of saddle showing formed X-CREPE undercovering.

Makes possible Custom-stitched Bike Saddles at Competitive Prices.

Style-minded bike manufacturers demanded handsome, custom-stitched bike saddles, wanted them at the *same price* as unstitched saddles. The problem: bike saddles have a metal core, and you can't stitch vinyl-coated fabric to metal. A stitchable, formable, waterproof undercovering was the only answer.

Troxel Manufacturing Co., "the finest name in saddles," experimented with vinyl-coated fabric and other similar materials, but found they were too costly.

Then Cindus product engineers recommended a waterproof grade of X-CREPE. It's formable, stitchable, has cloth-like texture and appearance—perfect for an undercovering. And it enables Troxel to *hold the line on materials costs.* X-CREPE sews easily without pre-punching holes—gives waterproof protection to inner elements, won't deteriorate.

Troxel is "in the saddle," laps ahead of competition with this high-quality product, priced just right.

This example is typical of hundreds of cases where manufacturers have standardized on X-CREPE because it fills a wide variety of needs better and more economically than less versatile materials. We can tailor X-CREPE to fit *your* needs.

See and feel an actual sample of X-CREPE in the 1954 HANDBOOK OF PRODUCT DESIGN.

Troxel lays die-cut sheets of black X-CREPE, vinyl-coated fabric and padding into a forming press with the pre-formed metal core—then stamps all together into a saddle sandwich. X-CREPE forms readily, holds its new shape well.

Next, the saddle sandwich is stitched and trimmed in one operation. Final stitching puts an attractive binding around the edge. See for yourself what a trim, saleable saddle it makes!

® *X-CREPE is the trademark of Cincinnati Industries, Inc., for its double-creped products.*

Write today for your FREE Cindus Design Engineer's Portfolio containing samples and complete information. Fits conveniently in your files.

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☐ *Please send me my FREE CINDUS DESIGN ENGINEER'S PORTFOLIO.*

☐ *Please have representative call.*

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*Title*_____

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YOU *helped create this superior Recording Oscillograph*

NEW *Type 5-119*

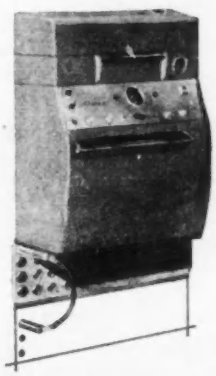
CONSOLIDATED's new Type 5-119 Oscillograph was designed and built to customer specifications. Many major users were interviewed by our design engineers to determine the features desired in a "perfect" instrument. Foremost demand was for great dependability. Second need indicated was for high trace capacity.

Dependability is achieved by extensive warning and test circuits and by reserve lamps which assure continuous recording in the event of lamp burn-out. Indicators warn immediately of any condition which could cause data loss, while additional circuits permit quick testing of the warning system. Design of the instrument assures reliable operation under the most rigorous environmental conditions.

Standard models provide either 36 or 50 traces. Consolidated's new Series 7-300 Galvanometers provide frequency response flat to 3000 cps. Standard record width of 12″ greatly simplifies record interpretation. Only after several prototypes were successfully tested under actual field conditions did we go into production on the 5-119—the new recording oscillograph leader. Write for Bulletin CEC 1536-X2.

SPECIFICATIONS

TRACE CAPACITY	36 or 50-trace models available
TRACE IDENTIFICATION	repeated, sequential trace breaks
RECORD WIDTH	12″ standard; narrower widths adaptable
RECORD MAGAZINE	removable, integral type; holds 250′ paper or film
RECORD SPEEDS	0.10 to 100 inches per sec. through quick-change gears, instantaneous switch-actuated, 10:1 speed jump
SCANNING SYSTEM	ground-glass screen and adjustable motor-driven polygon mirror; timing lines show on viewing screen
REMOTE OPERATION	accessory control unit with all essential controls & indicators
TIMING PROVISIONS	0.10 and/or 0.01 sec. lines photographed across record
EVENT NUMBERING	high-speed flash system operates as rapidly as one number per sec.
POWER REQUIREMENTS	115 volt, 60 cycle and 26 volt d-c models
INPUT PROVISIONS	all connectors on one rear deck; individual galvanometer plugs
CONTROL PANEL	all controls and indicators on single panel
ACCESSIBILITY	all adjustments can be made from one surface



The 5-119 can be panel mounted vertically with special shockmounts.

Consolidated Engineering

CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

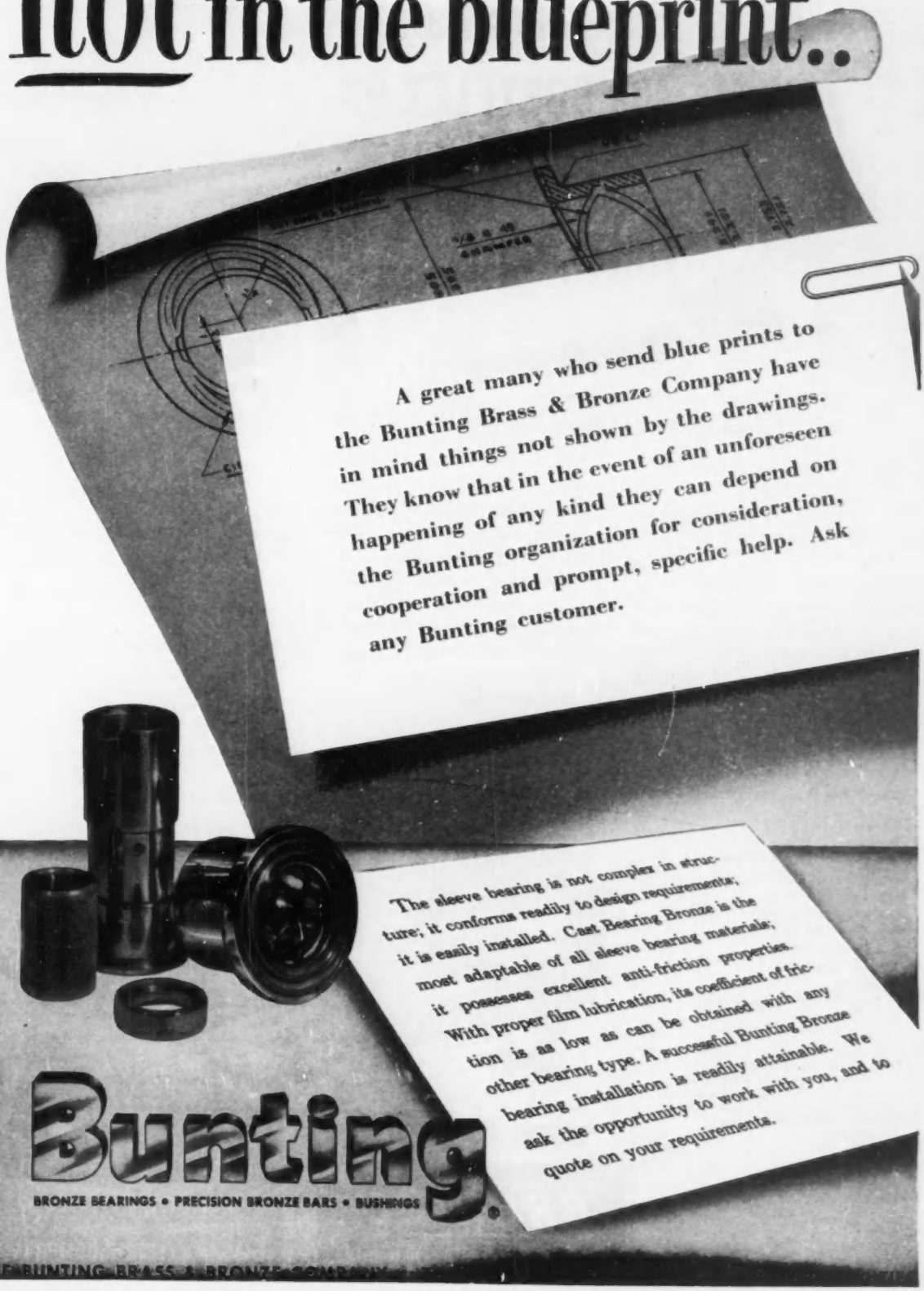
Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dallas.*

analytical instruments for science and industry

Recording Oscillographs

The Type 5-119 is the newest of 7 Consolidated Oscillographs ranging from 9 to 50 channel capacity. These versatile instruments simultaneously record any physical phenomena that can be transformed into electrical impulses. All measurements are obtained in clear, permanent form during the same operational cycle for future detailed analysis.

not in the blueprint..



A great many who send blue prints to the Bunting Brass & Bronze Company have in mind things not shown by the drawings. They know that in the event of an unforeseen happening of any kind they can depend on the Bunting organization for consideration, cooperation and prompt, specific help. Ask any Bunting customer.

The sleeve bearing is not complex in structure; it conforms readily to design requirements; it is easily installed. Cast Bearing Bronze is the most adaptable of all sleeve bearing materials; it possesses excellent anti-friction properties. With proper film lubrication, its coefficient of friction is as low as can be obtained with any other bearing type. A successful Bunting Bronze bearing installation is readily attainable. We ask the opportunity to work with you, and to quote on your requirements.

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THE BUNTING BRASS & BRONZE COMPANY

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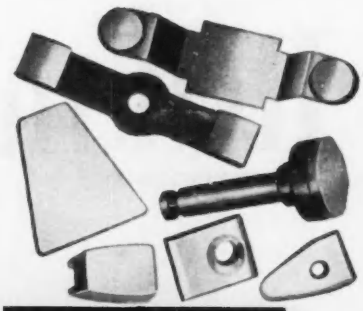

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When you buy Gibson Electrical Contacts for your electrical and electronic applications, you get:

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Gibson introduced to the industry Ductile Gibsiloys—contacts made from metal powders—to answer customer demand for combinations of physical and electrical properties not possible with alloyed contact materials. The versatility of Gibsiloys is ready to meet *your* needs.

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Manufactured by
GIBSON ELECTRIC COMPANY
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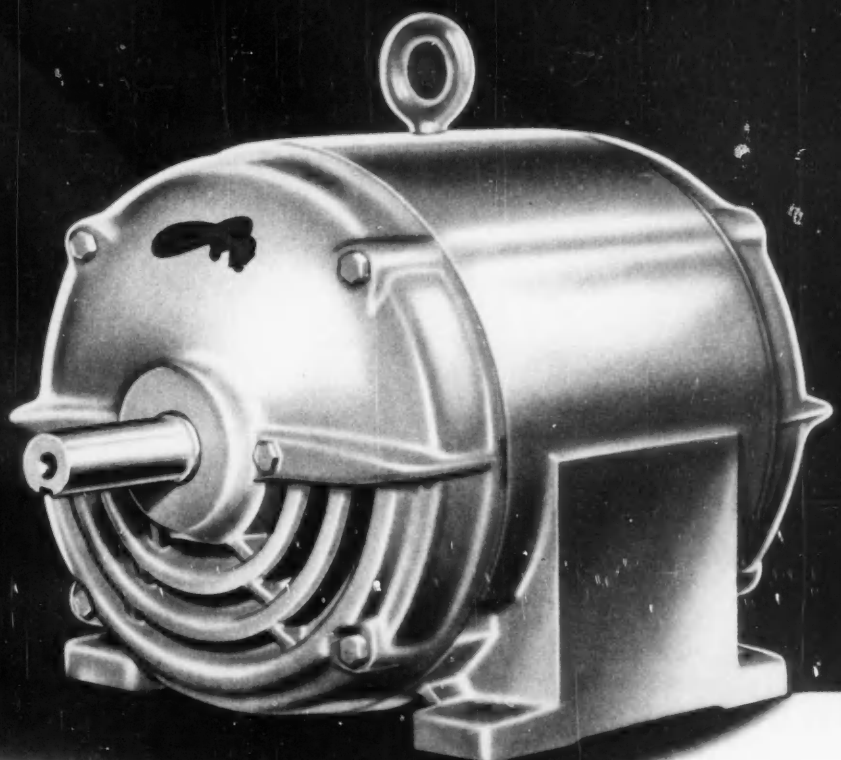
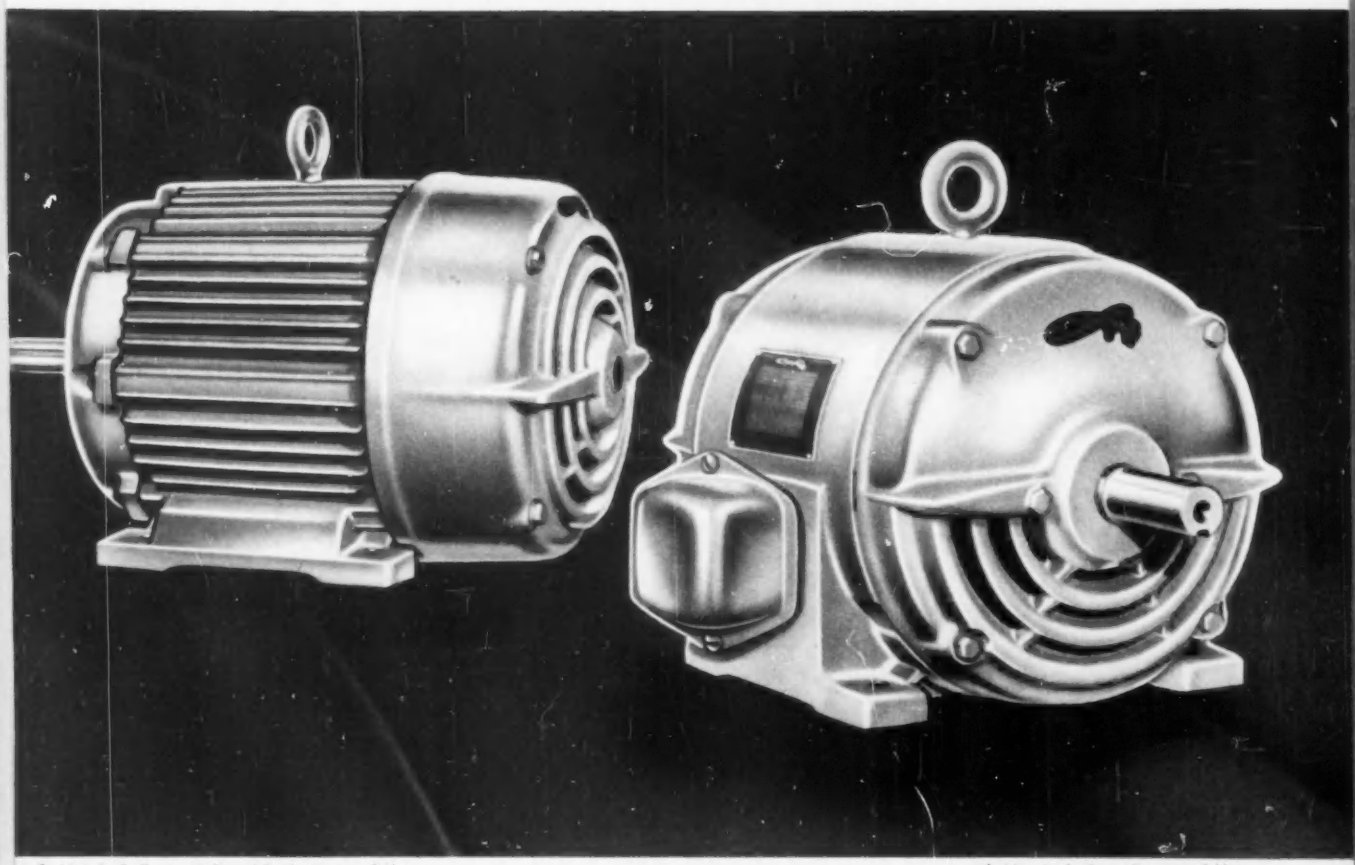
The Louis Allis Co. proudly presents the NEW L.A. *Line of electric motors*



. . . the concentrated utilization of over 50 years of engineering and development brings you this new concept in motors.

Please turn the page . . .

Here's new power for all standard and special motor applications



▲ New L. A. Fan-cooled and Explosion-proof Motor

▲ New L. A. Open Drip-proof Motor

From over 50 years of motor building experience and

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the first rapid-reversing motor
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comes the NEW *Line*

Here's the motor that's entirely new through and through, with such features as new modern styling... improved ventilation ...greater protection... new conduit box arrangement ...new bearing construction... and more versatile mounting. Get the facts on the most up-to-date motors available—the new L.A. line. See how these new motors can provide more power in a smaller package for your product or plant ...with the same high standards of Louis Allis performance, temperature ratings, service factors and torques. Call your Louis Allis Sales Engineer for the complete story.

Special Note *Louis Allis motors, built to the same high standards of quality and performance in the old NEMA standard frame sizes, will still be available if you require them for interchangeability or replacement.*

THE LOUIS ALLIS CO. · MILWAUKEE 7, WISCONSIN

Printed in USA

Facts you should know about DE LAVAL *worm gearing*

How master worm control gives you 4 vital advantages

This photograph shows inspector making a final check of contact and backlash on a De Laval gear set which has been process-inspected all along the line. A De Laval master worm "rides" with every job . . . insures start-to-finish quality control.

Since De Laval maintains a wide range stock of master worms as reference standards, you can be sure of:

- **Unvarying uniformity**
- **Correct thread thickness**
- **Preciseness of tooth contour**
- **Interchangeability of parts**

De Laval manufactures heavy duty worm gear sets in *ratios from 3:1 to 100:1, with ratings of .1 hp to 550 hp and center distances from 3" to 36".*

A New Working Tool for You!

Worm Gear Sets Catalog 5000 contains 38 pages of vital data. Write for your copy on your business letterhead.

DE LAVAL *Worm Gear Sets*

DE LAVAL STEAM TURBINE COMPANY

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DL 224

diversification

at Lockheed

in California

means

better careers for engineers

Lockheed's ability to develop and produce a wide range of aircraft is significant to career-conscious engineers.

1. It means Lockheed offers you broader scope for your ability.
2. It means there is more opportunity for promotion with so many development and production projects constantly in motion.
3. It means your future is not chained to any particular type of plane, because Lockheed is known for leadership in virtually all types of aircraft.
4. It helps explain why Lockheed has an unequalled record of production stability year after year.

report on diversification at Lockheed

diversified development projects

The most diversified development program in Lockheed's history is under way—and it is still growing. Lockheed recently announced contracts for the highly advanced XF-104 fighter and a study of nuclear energy applications to aircraft. Other projects include work on jet transports and missiles.

diversified production

The result of diversified development in the past can be seen in the wide range of planes now in production. Huge luxury airliners, cargo transports, jet fighters and trainers, bombers and radar search planes are rolling off Lockheed assembly lines. Twelve models are in production.

Lockheed AIRCRAFT CORPORATION

BURBANK, CALIFORNIA

Lockheed's program of diversified expansion has created openings for:

aerodynamics engineers
aerodynamicists "A"
aerodynamicists "B"
jr. engineers (for aerodynamics work)
a college degree in aeronautical engineering or a mechanical engineering degree with an aero option.

thermodynamics engineers
thermodynamicists "A"
thermodynamicists "B"
jr. engineers (for thermodynamics work)
a college degree in aeronautical engineering or a mechanical engineering degree with a thermo, aero or power plant option.

in addition, Lockheed's diversified expansion program has created immediate openings for:
service manuals engineers
flight test engineers

---

design engineer "A"
design engineer "B"
seven years' training and experience including four years' university engineering training and three years' layout drafting or shop liaison in aircraft or closely allied fields.

jr. engineer — draftsmen "A"
five and one-half years' training and experience including four years' university engineering training and 18 months' detail or layout drafting on aircraft or related fields.

jr. engineer — draftsmen "B"
an engineering degree from a recognized school of engineering. Experience is not required of recent engineering graduates.

Lockheed invites qualified engineers to apply for these positions. Coupon below is for your convenience.

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Engineering Recruiting, Dept. PE-12
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Burbank, California

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give constant high efficiency despite wear

...outlast other packings over 3 to 1!

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Net Advantages — Pumcups maintain high volumetric efficiency, permit reduced operating speeds, save power, prolong equipment life and eliminate the need for frequent replacement shutdowns.

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The Rubber Heat Pad is patented by Lamac Process Company, Erie, Pa.

CURED A PRODUCTION HEADACHE

This electrically heated rubber pad has reduced the time required for re-soling shoes in the famous Lamac Press by as much as 75%.

Continental made this improvement possible because it was able to develop a rubber compound that withstands the sustained heat generated by the electrical heating element. Continental also solved the equally difficult problem of positioning this heating element so that it would not shift and "short" itself when the pad was molded.

The success of this development is another example of the specialized assistance in rubber which Continental offers to design and production engineers.

LET US SEND YOU THIS CATALOG

This new engineering catalog lists hundreds of standard grommets, bushings, rings and extruded shapes. It will be a valuable addition to your working file. Send for your copy today or . . .

See our Catalog in Sweet's File for Product Designers

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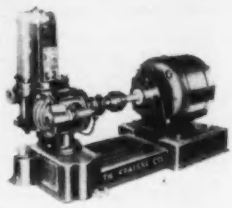

Rotary Air Pumps for vacuum bottling

Kraissl's patented, automatic, force-free lubrication and flushing system makes these direct-drive, high-capacity pumps ideal for the special requirements of bottle-filling machinery.

Air-cooled design — or water-cooled models for heavier duty.

Class 21 roller-action pumps are recommended for handling corrosive gases and extraneous matter that might jam with closer clearances. The multi-blade design of the Class 25 pumps gives higher capacity efficiences and is designed for applications requiring higher degree of vacuum.

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EXCLUSIVE CLASS 26 AIR FILTER

is available as an integral part of each pump up to 10 cfm—to produce oil-free discharge air and also conserve the lubricating oil.

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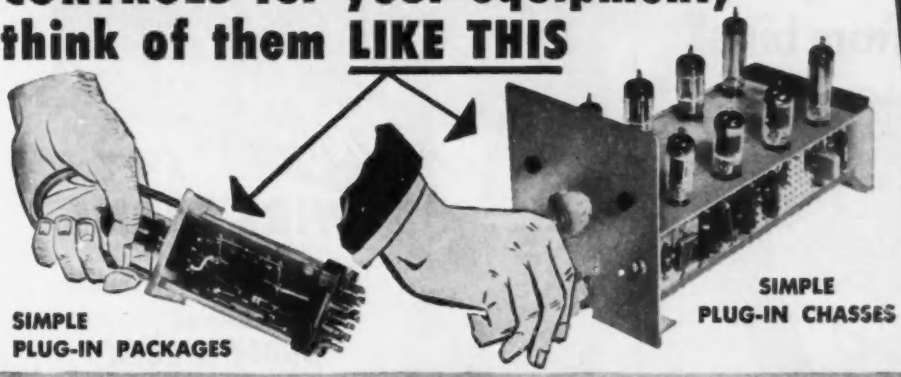
289 Williams Ave., Hackensack

In visualizing AUTOMATIC ELECTRONIC CONTROLS for your equipment, think of them LIKE THIS



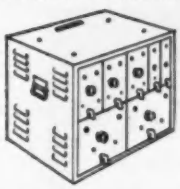
Are your prospects afraid of the "Little Black Box?"

Your wonderful new Electronic Controls may mean the death of a sale — unless the cautious buyer sees that his own personnel can locate and correct Control troubles on the spot.

Any electronic equipment can now be subdivided into simple plug-in units that for the first time assure your users RELIABILITY IN SERVICE

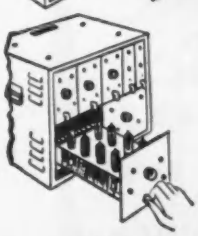
(The User's own personnel can locate and correct most troubles on the spot)

Here are the bold new Standards:

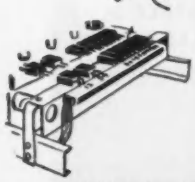


1 Circuitry subdivided, function by function into plug-in units.

2 Tiny telltales spot trouble instantly.



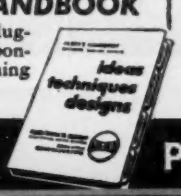
3 Plug in replacement spares in 30 seconds.



4 All leads brought to single accessible point of check — all numbered, color-coded — so layman can make first-level tests.

REQUEST FREE HANDBOOK

Describing complete system of Plug-in Unit Construction and Components. 226 pages and many Planning Sheets.



Here's how to get them: IT'S AS SIMPLE AS THIS –

1. ***Unitize your circuitry in compact vertical planes using Alden Terminal Card Mounting System.***

PREPUNCHED TERMINAL MTG. CARD
MINIATURE TERMINALS
JUMPER STRIP Eliminates wiring for common circuits
CARD-MTG. SOCKETS
YOUR COMPLETED CIRCUITS FOR PLUG-IN PACKAGE OR CHASSIS

You can use Alden Terminal Mounting Card with Alden Miniature Terminals, Jumper Strip and Sockets soaked to accommodate *any circuitry* — making complete units ready for housing. Components snap into unique Alden Terminals, are held ready for soldering.

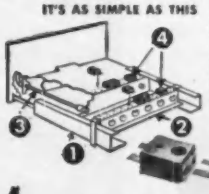
2. **To mount this vertical circuitry, ALDEN PLUG-IN PACKAGES AND BASIC CHASSIS give tremendous variety with standard components**

ALDEN PLUG-IN PACKAGE
4 SIZES: 7, 9, 11 & 20-PIN
ALDEN BASIC CHASSIS 2", 4", 8" & 17" widths
Plugged into Standard Racks
Plugged into Alden Uni-Racks
Plugged into Portable Cases

Standard Alden components provide tremendous variety to build almost *any circuitry* as plug-ins. With spares, your circuits are units replaceable in 30 seconds.

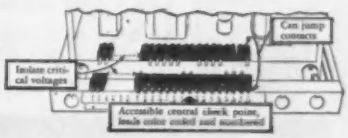
3. **Give chassis easily traceable interconnects and 30-second replacement with ALDEN SERVE-A-UNIT KIT**

IT'S AS SIMPLE AS THIS

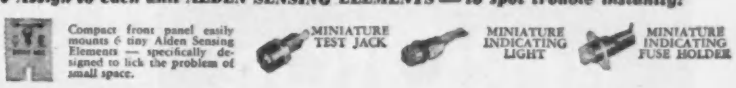


Arrange Alden Side Rails (1) and Alden Lock Frame (2) to suit your chassis. Alden Serve-A-Unit Locks (3) mount in your chassis to engage pre-punched holes in Alden Lock Frame (2) to pilot, draw in, lock or eject your chassis. Arrange Alden Back Connectors (4) in orderly row on Alden Lock Frame. Mount mating Alden Back Connectors on your Chassis.

GIVING YOU 1) Chassis that plugs in, locks and ejects with half turn of the wrist. 2) leads so beautifully organized, accessible and identified that non-technical personnel can service.



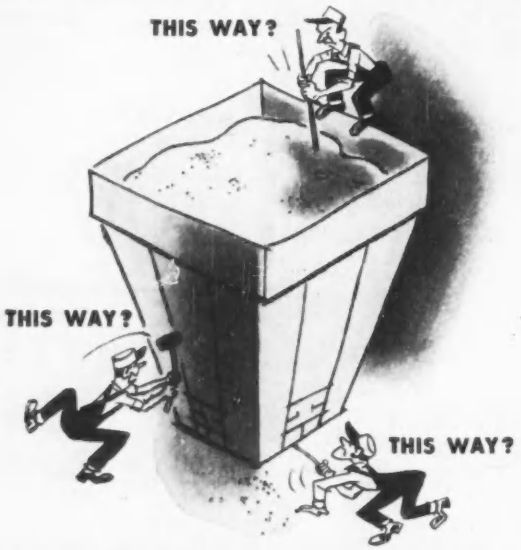
4. ***Assign to each unit ALDEN SENSING ELEMENTS — to spot trouble instantly:***


Compact front panel easily mounts 6 tiny Alden Sensing Elements — specifically designed to lick the problem of small space.
MINIATURE TEST JACK
MINIATURE INDICATING LIGHT
MINIATURE INDICATING FUSE HOLDER

By thinking of your Electronic Controls in terms of ultimate plug-in units — you lick the problem of RELIABILITY IN SERVICE for your Customer . . . and you wash out problems of Design, Manufacture and Procurement for all concerned.

NA-ALO **ALDEN PRODUCTS CO.** 135 N. Main St., Brockton 64, Mass.

How do YOU keep stuff flowing from bins?



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Delays . . . dangers . . . damage and din . . . PneuBin does away with them all! Pulsating neoprene panels, mounted inside the walls, keep stubborn materials flowing from any type of bin or hopper. They work noiselessly, by positive displacement . . . move the contents, not the bin.

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THEY LOOK ALIKE

Cast rail and fabricated base assembly

One-piece Gray Iron rail

...but compare production costs!

GRAY IRON CHARACTERISTICS INCLUDE:

Castability
Strength
Rigidity
Low Notch Sensitivity
Wear Resistance
Heat Resistance
Corrosion Resistance
Durability
Vibration Absorption
Machinability

One-piece Gray Iron casting cuts machining and assembly steps

Still another manufacturer has found that one-piece Gray Iron castings lower production costs and improve product performance.

Shown above are two types of main rails along which an oxyacetylene shape cutting machine travels. One is a two-piece assembly . . . the other is all Gray Iron.

By redesigning as a one-piece Gray Iron casting, this manufacturer eliminated two machining operations and one assembly operation formerly required to make the fabricated rail. Because of the inherent dimensional stability and rigidity of Gray Iron, cutting accuracy of the machine is held to .015″ over the 12′ of travel.

Have you taken a good look at the cost-saving and improved performance possibilities of redesigning your fabricated parts for Gray Iron casting? Why not let us help you—write for technical information on the many advantages of the Gray Iron casting process.

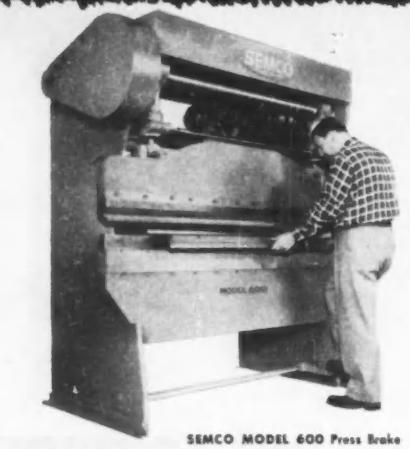
MAKE IT *BETTER* WITH GRAY IRON

75% of all cast metal products are Gray Iron

GRAY IRON FOUNDERS' SOCIETY, INC.

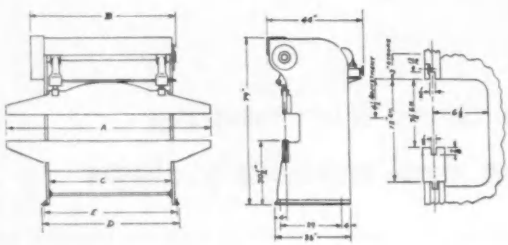
NATIONAL CITY-E. 6th BLDG. CLEVELAND 14, OHIO

Big... PRESS BRAKE STANDARDS at small press cost–



SEMCO MODEL 600 Press Brake

MODEL NUMBER	BENDING CAPACITY MILD STEEL	A	B	C	D	E	STROKE	RAM ADJ.	STROKES PER MIN.	MOTOR H.P. and R.P.M.
600	72"-14GA	72"	66"	58"	64"	62½"	3"	4½"	16 to 40	1½
800	96"-16GA	96"	66"	58"	64"	62½"				1800



EXTRAS that you get at no additional cost are often the features of presses costing twice as much. Take the BUTTRESS THREADS in a revolving bronze nut with release grooves to prevent jamming and the FINE ADJUSTMENT—one revolution of the hand crank gives a precision ram adjustment of .0125".

A cast steel fly-wheel of EXTRA size, a one piece crankshaft of forged alloy steel, ball and roller bearings throughout with alloy bronze bearings in the eccentric crankshaft. These are but a few of the EXTRA quality features in the SEMCO PRESS BRAKE.

Made by the makers of famous "34 year" BRAKE DIES.

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SEMCO

SERVICE MACHINE CO., Inc.

152 MILLER STREET, ELIZABETH 4, N. J.

The CUYAHOGA SPRING Co.

SUBSIDIARY OF THE BARIUM STEEL CORP

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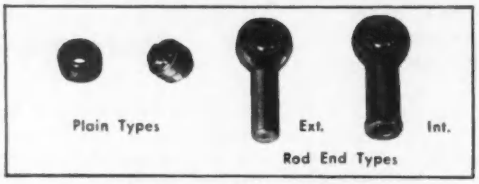
"MONOBALL"®

SELF-ALIGNING BEARINGS



CHARACTERISTICS

ANALYSIS

1. Stainless Steel Ball & Race
2. Chrome Molly Steel Ball & Race
3. Bronze Race & Chrome Molly Steel Ball

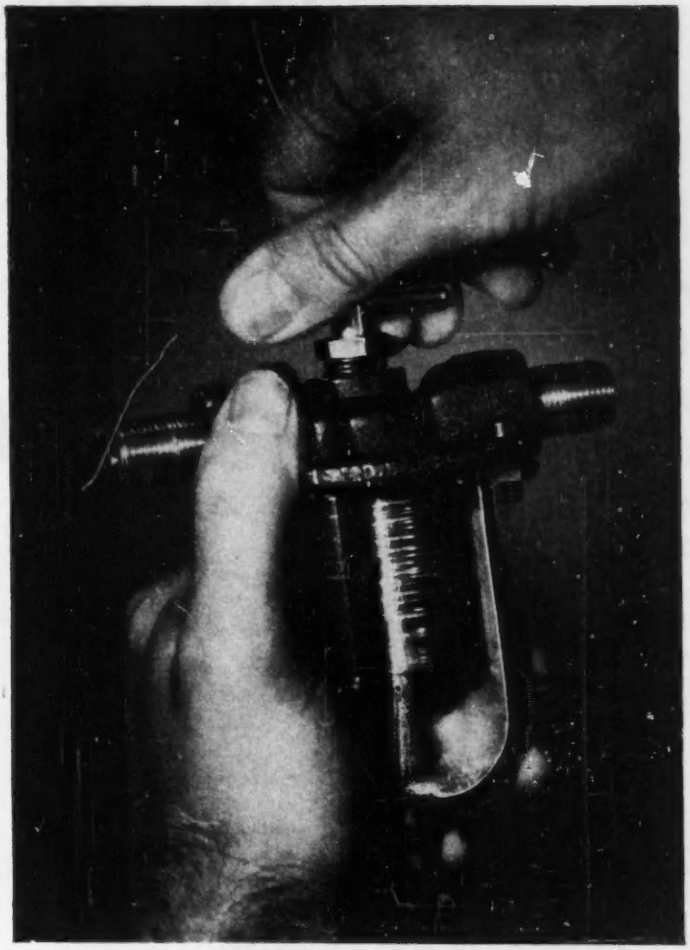
RECOMMENDED USE

1. For types operating under high temp. (800—1200 degree F.)
2. For types operating under high radial ultimate loads (3000—893,000 lbs.).
3. For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Field Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. New types have been developed, many as a result of specific requirements of our customers. Write or wire now for revised Engineering Manual describing complete line of "Monoball" Self-aligning Bearings and Rod Ends. Please address Dept. PE-53.

SOUTHWEST PRODUCTS CO.

1705 S. Mountain Ave. Duarte, Calif.



JUST A twist OF THE wrist

That's all it takes to clean the Cuno AUTO-KLEAN—the strainer that can be continuously cleaned while it's working.

Turning the handle one revolution moves the strainer element through comb blades, removing all dirt from strainer surfaces. Dirt particles fall to bottom of housing, where they can be drained off periodically. Cuno's exclusive combing operation cleans thoroughly—without costly interruption of fluid flow.

- AUTO-KLEAN's permanent metal filter element is available in steel, brass or stainless steel for long trouble-free service under any conditions.
- AUTO-KLEAN is adaptable to any fluid-flow system.
- From acids to tar . . . if you can pump it, Cuno can filter it. Capacities range from one gallon per hour to 3,800 gallons per minute.

A.3.8

CUNO

ENGINEERED FILTRATION

Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (disc-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound)

CUNO'S AUTO-KLEAN ELIMINATES NEED FOR STAND-BY STRAINERS

Compact strainer can be built-in or installed externally

Design engineers are finding that they don't need to use a duplex strainer installation to get all the solids out of fluids used in their equipment. A *single* Cuno AUTO-KLEAN strainer does the job.

This is possible because fluid flow doesn't have to stop while this strainer is being cleaned. Cuno's exclusive "comb-clean" action provides complete cleaning of the strainer element—*without stopping fluid flow.* Thus one strainer provides non-stop filtration, with no need for stand-by units.

Customers like the way AUTO-KLEANs save on maintenance bills, for there aren't any cartridges to change. Occasional rotation of the handle does the cleaning. (Most units can be equipped with motor-drives for continuous cleaning.)

This compact strainer gives full-flow filtration in space which would limit ordinary filters to by-pass service. And its low pressure drop permits this full-flow service on gravity or low-pressure lines, with no loss in operating efficiency.

You can build AUTO-KLEAN right into your product, or get it in its own housing for external installation.

AUTO-KLEAN's metal discs stop all solids larger than the specified disc spacing — from .0035" (170 mesh) to .062" (12 mesh). Discs come in a number of corrosion-resistant materials, to handle any liquids.

Send coupon today for free AUTO-KLEAN bulletin.

A.3.18

Cuno Engineering Corporation
Dept. 3818S South Vine St., Meriden, Conn.

Please send me bulletin on Cuno AUTO-KLEAN

for.....
(fluid)

Name.....

Company.....

Address.....

City.....Zone....State.....

What are your requirements ?

any type of gear in any size and any material for every industrial purpose custom-made by Perkins!

No matter what your gear requirements may be – no matter how large or small the order – have PERKINS quote on them first.

PERKINS MAKES: helical gears, bevel gears, sprockets, ratchets, worm gears, spiral gears, spur gears with shaved or ground teeth, ground thread worms

PERKINS MACHINE & GEAR CO.
WEST SPRINGFIELD, MASS.
A Gear-Engineering Organization

NOTE 1: A new product is the **Perkins Precision Spring Coiler.** This coiler (patent applied for) turns out precision springs – any type, shape, size, from wire sizes .005 to .125.

2: Another new product – the **Perkins "Bendit 15"** – a patented metal forming machine bends and shapes sheets, rods; strips tubing into innumerable complex as well as simple forms that would be difficult or impossible to make by other means. Eliminates need for expensive tools or specialized skills. Ht. 47", net wt. 200 lbs. Write today for descriptive catalogs, prices etc.

154 ideas on ways to use...

154 varied applications of molybdenum sulfide in the shop and in the field are described in a new booklet now available. This solid-film lubricant has demonstrated unique anti-friction properties under conditions of extreme pressure, high velocity, elevated temperature, or chemical attack.

The 40-page booklet contains the records of solved lubrication problems — some might solve your own.

Moly-sulfide
A LITTLE DOES A LOT

The lubricant for extreme conditions

Climax Molybdenum Company
500 Fifth Avenue
New York City 36 N Y

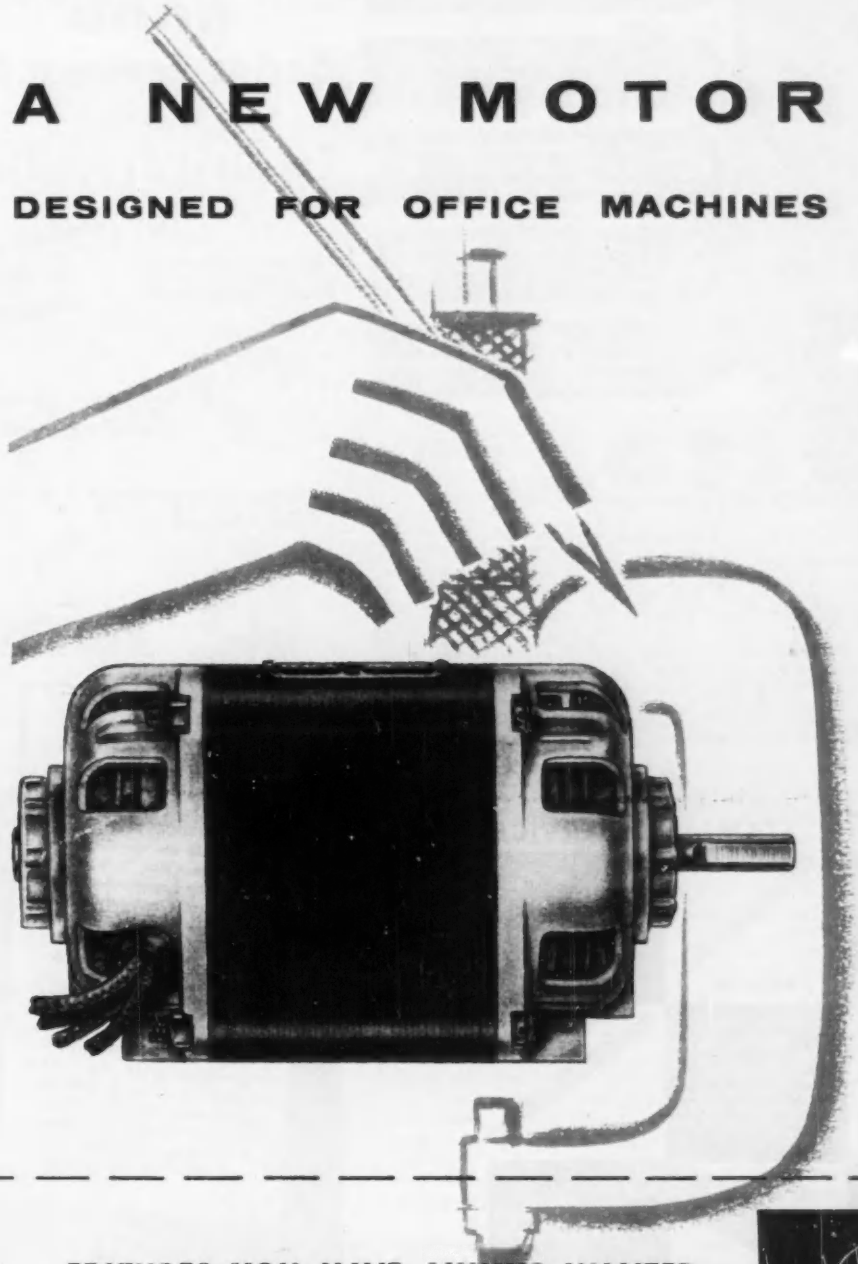
Please send me your Free Booklet on *Moly-sulfide*
Name.....
Position.....
Company.....
Address.....

MOLY

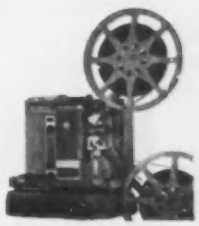
PE-12 MS-6A

A NEW MOTOR

DESIGNED FOR OFFICE MACHINES



FIELD-TESTED, TOO, IN THESE AND OTHER LEADING PRODUCTS



Eastman Kodak Pageant Projector

Royal Electric Typewriter

Permoflux Dictating Machine

FEATURES YOU HAVE ALWAYS WANTED

Constant speed...extremely quiet operation...height and width of only 2⅞ inches...5 mounting arrangements...no radio interference ...covenient rectangular shape...low temperature rise...and light weight are characteristics of the new Bodine Type K-4 Induction Motor that make it ideally suited for *office machines, movie projectors, automatic phonographs, communication equipment, etc.*

The K-4 is available as either a split-phase or capacitor type of motor. Large quantity orders can be filled in a relatively short period of time. Bodine experienced engineers will be pleased to help you apply this precision-built motor to your product.

BODINE ELECTRIC CO., 2260 W. OHIO STREET, CHICAGO 12, ILL.

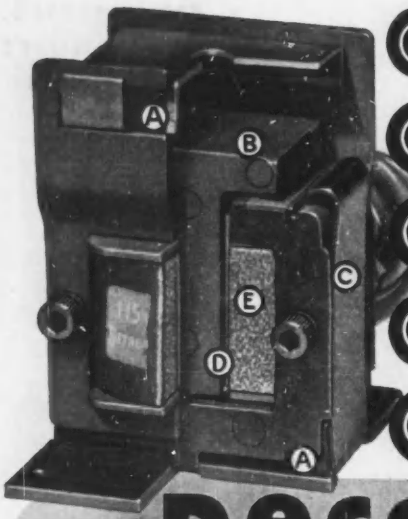
Representatives in principal cities. In Canada: Renold-Coventry, Ltd.

BODINE

Bodine

FRACTIONAL HORSEPOWER

MOTORS



(A) Shock-absorbing bumpers cushion stroke, assure longer service life.

(B) Silicon steel laminations give high efficiency.

(C) Tempered steel spring absorbs vibration — holds assembly firmly in alignment.

(D) Hardened beryllium-copper plunger guide reduces friction and wear.

(E) Heavy Formvar insulated magnet wire on high flow point molded nylon bobbin.

Decco INDUSTRIAL SOLENOIDS

Built better for longer service.
Shock mounted to reduce self-destruction.
Designed to meet J. A. C. specifications.
Four to twenty pounds—push or pull.
Stroke to one inch maximum.
A. C. or D. C. models.

Special solenoid problems engineered to your needs.

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Federal ONE STOP STAMPING SERVICE:

DRAWING

PIERCING

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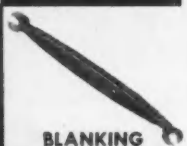
TAPPING

FREDDY FEDERAL SAYS:
"A little bit here and a little bit there is a little bit inefficient! Lets get *all* those jobs pinpointed at FEDERAL and save time, trouble, and expense."


BLANKING

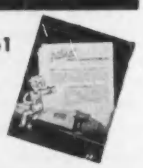
FORMING

STENCILING

EXTRUDING

101

WRITE TODAY!
Tell us where to send these BULLETINS earmarked for you.
And when you're writing, why not send us the specs for that stamping job coming up? . . . We'll send you a quotation with no strings attached.

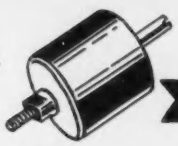

161

Federal TOOL AND MANUFACTURING CO.
3620 ALABAMA AVE. ST. LOUIS PARK
MINNEAPOLIS, MINNESOTA
QUALITY STAMPINGS IN SMALL QUANTITIES

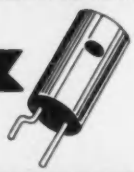
HYSOL 6000 Series Compounds provide Excellent Properties for

RESISTORS

CAPACITORS



TRANSISTORS



COILS

HYSOL epoxy compounds are used extensively for impregnating, potting or encapsulating electronic components like those illustrated above. HYSOL 6000 Series compounds are specified because Houghton Laboratories Inc. has cooperated with its customers, not only in the development of a specific material for a specific purpose, but also in the development of methods of making molds and follow thru to product acceptance.

Why not call on the HYSOL technician when you want product improvement? We can "work it out" together in your laboratories or ours. Our frank, honest opinions are yours for the asking.

PROGRESSIVE PRODUCTS THRU CHEMICAL RESEARCH
HYSOL
Product of HOUGHTON LABORATORIES, INC.

houghton laboratories, inc.
345 Bush St.
OLEAN, NEW YORK

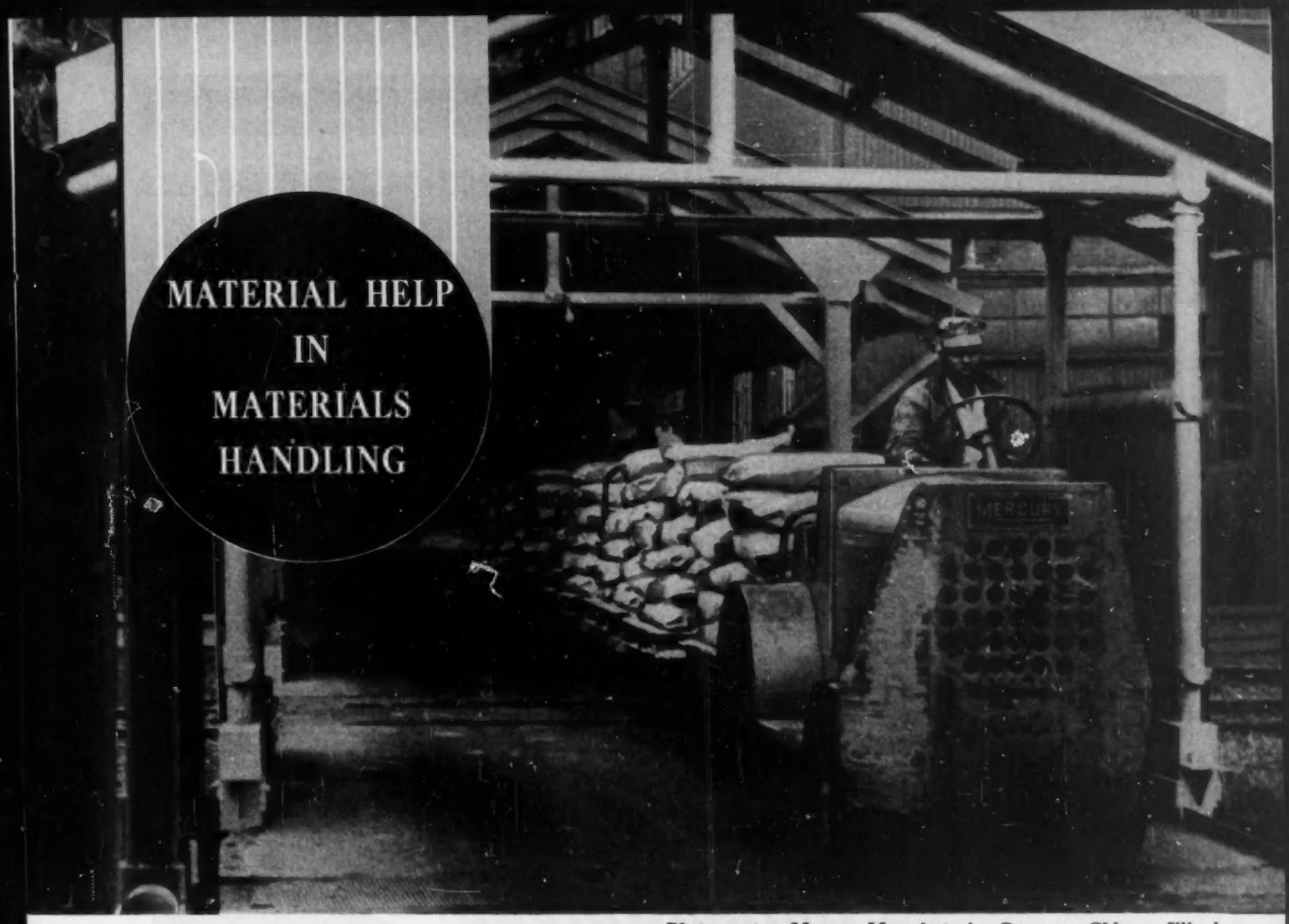
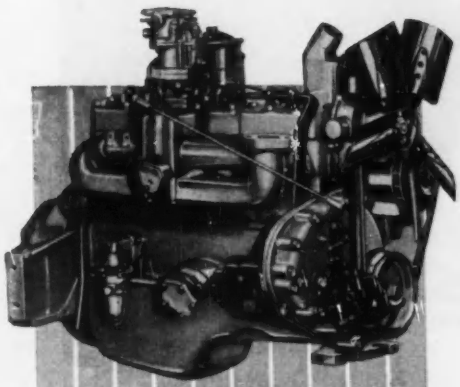


Photo courtesy Mercury Manufacturing Company, Chicago, Illinois

Pedigreed Power moves the products of industry . . . faster and at less cost



Every day is moving day in Industry. Raw materials, parts and finished products *must* move if supply is to meet demand. The system for moving materials in and around a modern industrial plant must be fast, economical and have the flexibility necessary to meet fast-changing requirements. Best solution is the modern towing tractor, small enough to scoot anywhere in the plant, powerful enough to pull loads heavier than itself.

Take the Mercury "Huskie" pictured here . . . it can pull a load over 60 tons at a sustained speed of two and a quarter miles per hour. It can be equipped with snow plow, power-driven winch or sweeper-broom. Powering the "Huskie" is the six-cylinder, 251 cubic inch displacement Model 8 Chrysler Industrial Engine equipped with Chrysler four-speed transmission and velocity governor. Small, compact, with an amazing power-to-weight ratio, this engine is ideal for equipment requiring a light-weight, powerful engine.

Any Chrysler Industrial Engine, open or enclosed power unit, can be supplied with gasoline, natural or LP gas-burning carburetor, standard or gear-driven front ends (magneto or hydraulic pump drive), mechanical or velocity governor, standard, gyrol Fluid Coupling or torque converter transmission.

Remember, too, that Chrysler Power is not expensive. Production-line methods, adapted to specialized industrial engine building, provide a custom-built engine at mass-production prices. See a Chrysler Industrial Engine Dealer, or write: ***Dept: 412, Industrial Engine Division, Chrysler Corp., Trenton, Mich.***

CHRYSLER
Industrial Engines

HORSEPOWER WITH A PEDIGREE

need information on

metals?

reach for your Product Design File

"...a great time-saver"

These manufacturers' catalogs are instantly available in Section 1A of your Product Design File

Allegheny Ludlum Steel Corp.	Jones & Laughlin Steel Corp.
Aluminum Co. of America	Kaiser Aluminum & Chemical Sales Inc.
Ampco Metal, Inc.	Michigan Steel Tube Products Co.
Apollo Metals Works	Mueller Brass Co.
Armco Steel Corp.	Ohio Seamless Tube Co.
Babcock & Wilcox Co.	Republic Steel Corp.
Baker & Co.	Republic Steel Corp. Steel & Tubes Div
Beryllium Corp.	Revere Copper & Brass Inc.
Bethlehem Steel Co.	Reynolds Metals Co.
Bishop, J., & Co.	Rigidized Metals Corp
Brooks & Perkins, Inc.	Rochester Products Div. General Motors Corp
Bundy Tubing Co.	Rodney Metals, Inc
Carpenter Steel Co. stainless steel steel tubing	Sharon Steel Corp.
Dow Chemical Co.	Standard Tube Co
Fairmont Aluminum Co.	Superior Tube Co.
General Electric Co.	U. S. Steel Corp
Globe Steel Tubes Co.	Washington Steel Corp
Great Lakes Steel Corp. N-A-X Alloy Div	Weirton Steel Co
Harvey Machine Co.	Werner, R. D., Co
International Nickel Co.	

In other sections of the File you will find additional catalogs containing useful information on product forms, characteristics, performance and use

Sweet's Catalog Service

Division of
F W Dodge Corporation
119 West 40th Street, New York 18, N. Y.

Speeding X-Ray Photography

with

EEPCO-DESIGNED MOTORS

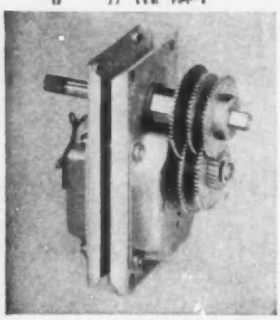
Manufacturing X-Ray equipment calls for precision and dependability in every part.

That's why, when the nation's three leading manufacturers of X-Ray machines chose the motor that moves the delicate negative holders, they selected motors designed and built by EEPCO.

These tiny motors of 1/500 h.p. (intermittent service) provide the reliable, steady source of power that revolves the negative changing mechanism. After a photo is made, the exposed negative with its lens and shutter, are automatically moved aside and a new unit moved into the ready position. Handling this task demands an even, slow application of power to avoid damage to the delicate mechanism. This is typical of the many unusual applications to which EEPCO-designed motors have been put.

If your particular problem calls for special design, or merely for standard motors that can handle the toughest service, you'll find that EEPCO is the source on which to depend. Out of the many unusual requirements filled by EEPCO engineers has come experience unsurpassed in industry and always at your disposal.

Equally important, the EEPCO plant is well-equipped and staffed to turn out motors for you on a mass-production, low-cost basis when necessary.



Write today for complete details and catalog information

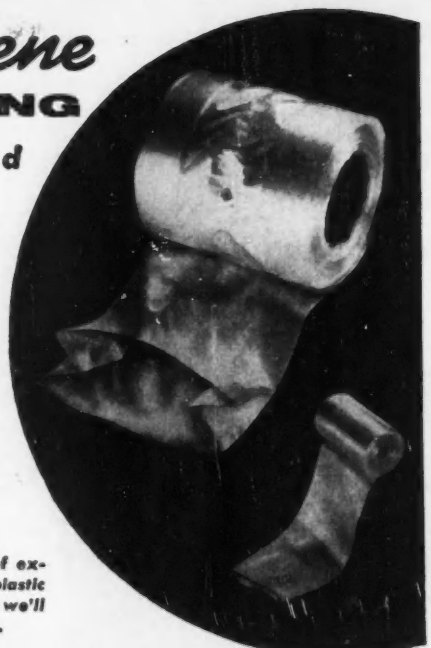
ELECTRO ENGINEERING PRODUCTS CO.
609 W. LAKE STREET, CHICAGO 6, ILLINOIS

• P-M DC MOTORS & GENERATORS • CAPACITOR TYPE MOTORS • UNIVERSAL MOTORS
• DC MOTORS & GENERATORS • SHADED POLE MOTORS (2-4-6 Pole) • P-M AC GENERATORS

Polyethylene
FLAT TUBING
Plain • Gusseted

We will be happy to quote you prices and delivery dates on any quantity of Polyethylene flat tubing, plain or gusseted, in widths from 2" to 38" and in thicknesses from .00125 to .006. Try H & R and discover why many of the leading packaging concerns enjoy dealing with H & R for all their flat tubing needs.

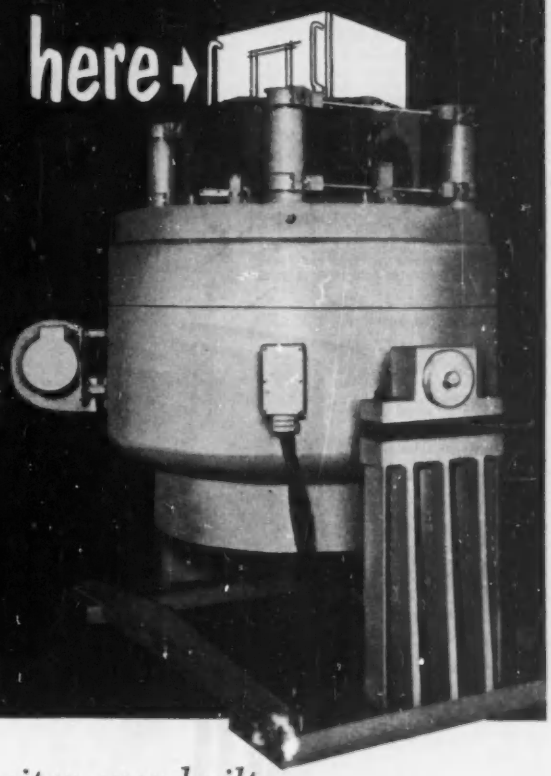
We also make many other types of extrusions from a wide variety of plastic materials. Outline your needs and we'll be glad to furnish full information.



PROPER APPLICATIONS... *Product Improvement*

H & R INDUSTRIES *Extruded Plastics*
344 E. WALNUT ST., NAZARETH, PENNA.

Put your product here to shake-test it with 10,000 lbs force



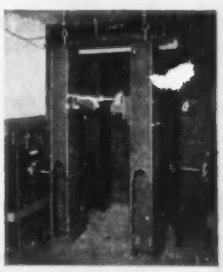
MB produces the largest exciter ever built to meet heavy duty vibration test specifications •

THERE's nothing like a good shaking to test out structural designs, electronic equipment, instruments or complete assemblies for faults or flaws. In fact, for many products put to military use, such tests are *specified*. However, since *all* products encounter some vibration or shock in service, many engineering departments use an MB Exciter to test all designs. By so doing, the "bugs" are discovered in the test laboratory instead of out in the field, at cost of good will.

Largest in the line of MB electromagnetic shakers, the Model C-100 shown delivers at least 5 tons continuous force. Its performance permits heavy duty vibration testing to MIL-E-5272 and other specifications. It incorporates a number of unusual design features for easy, quick, convenient operation—including interlocking controls for complete safety and provisions for cycling tests.

HOW TO HANDLE LARGE MASSES

MB can show you a setup of vibration exciter and resonating beam that multiplies the capacity of versatile MB Exciters many fold. Shaker being used in this fatigue strength test of aircraft engine mounts is the model S-3 rated at 200 lbs. Others available down to 10 lbs. force output.



Vibration is MB's specialty. You're invited to draw on the benefits of this specialization—and get highly qualified products for testing and control, and technical help on your problem.

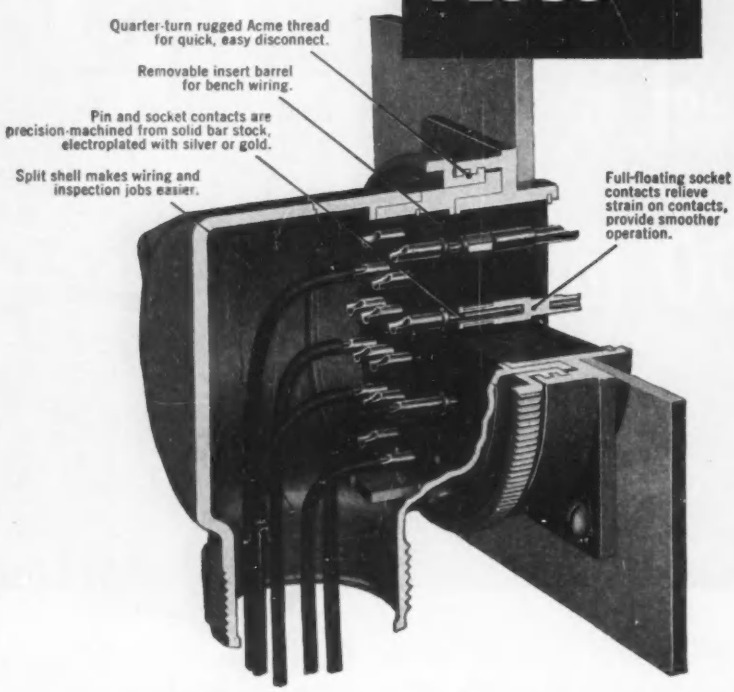
Valuable bulletins for test engineers Calibrating vibration pickups to 2000 cps is comprehensively covered in MB Bulletin No. C-11-1. Bulletin No. 1-VE-1 describes vibration exciters and details their specifications. Write today.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO INDUCE VIBRATION...TO MEASURE IT...TO ISOLATE IT

Here's why those in the know –demand

CANNON PLUGS


Quarter-turn rugged Acme thread for quick, easy disconnect.
Removable insert barrel for bench wiring.
Pin and socket contacts are precision-machined from solid bar stock, electroplated with silver or gold.
Split shell makes wiring and inspection jobs easier.
Full-floating socket contacts relieve strain on contacts, provide smoother operation.

Recognition of Cannon's 36 years of sound engineering and fine, uncompromising construction has built the demand for Cannon Plugs. Here we take an inside look at the lightweight Type "K" 90° connector, forerunner of the Army-Navy Series. More features of the "K" were incorporated into the "AN" design than any other connector.

Constantly improved over the years, Type "K" is now used for numerous applications such as aircraft, radio, television, sound, phone recorders, motion pictures, geophysical research and widely used throughout the electro-mechanical and electronic instrument fields.

The design and construction details in the Cannon "K" Series are typical of the care Cannon takes in producing more than 18,000 precision, multi-contact connectors to serve the exacting needs of industry.

We will gladly send you engineering bulletins describing each of the many basic types of Cannon Plugs if you will briefly describe your applications.

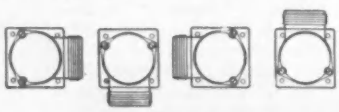


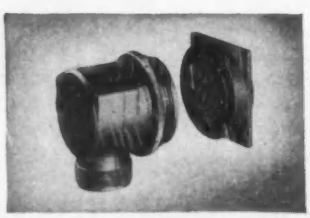
Diagram at left shows how the four positions of cable entry on the large 90° "K" endbell make the wiring job easier. Smaller Type "K" connectors have three positions.

CANNON ELECTRIC

Since 1915

Cannon Electric Company
Los Angeles 31
California

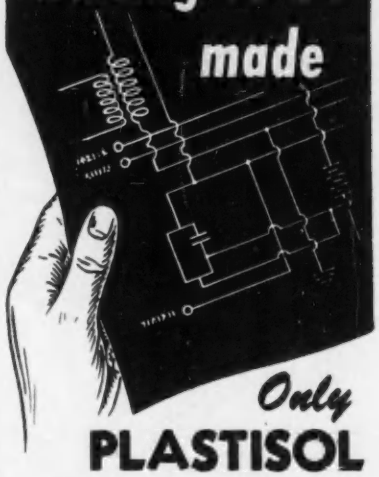
Factories in Los Angeles, Toronto, New Haven. • Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. L-106, Los Angeles 31, California.



Type "K" and "RK" connectors are available in 7 shell types having 8 diameters. Inserts have more than 190 contact arrangements. Some of these have Coax, Twinax or Thermocouple contacts as standard. Integral cable clamps available in all "K" plug types.

ELECTRICAL

For products waiting to be made



Only

PLASTISOL INSULATION

for Molding, Extruding or Dipping can be specifically compounded to produce these advantages:

- **Ease of molding or coating — inexpensive molds or equipment required**
- **Good aging properties under normal operating temperatures**
- **Low temperature flexibility**
- **Good outdoor durability**
- **Resists most acids and alkalis**
- **Good flame resistance**
- **Resistance to oil and grease**

Whatever you manufacture, from spaghetti wiring to circuit-breaker panels, Stanley chemists can formulate a vinyl plastisol to meet your most exacting insulation requirements. For specific information write *today* to the Stanley Chemical Co., 82 Berlin St., East Berlin, Conn.

Industrial Coatings

STANLEY CHEMICAL

LACQUERS · JAPANS · SYNTHETICS · ENAMELS

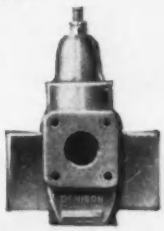
For lasting efficiency with less maintenance, specify

DENISON HydrOILic

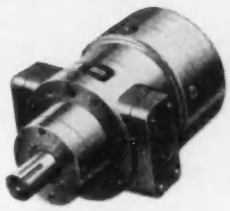
PUMPS, MOTORS, CONTROLS

For circuit pressures to 5000 psi

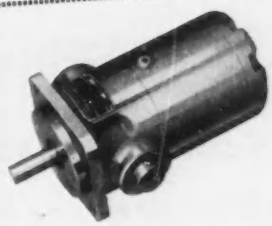
SURGE-DAMPING CONTROLS
Industrial and Aircraft Types
Eliminate Destructive Hydraulic Pressure Shock
¼" to 1" Sizes
For Pressures to 5000 psi
Catalog VS-1-A



Direct-Operating PRESSURE CONTROLS
½" to 1½" Sizes
For Pressures to 2000 psi
Catalogs VRD-1 through VRD-8

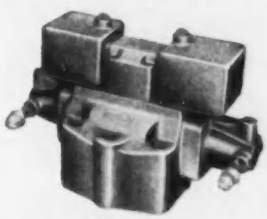


High-Pressure Axial-Piston PUMPS
Constant or Variable Volume
For 2500, 3000 and 5000 psi Circuit Needs
3.5 to 35 gpm Capacities
Catalogs P-4 through P-4-10

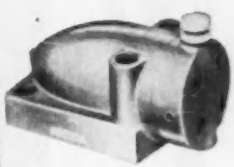


High-Torque Axial Piston FLUID MOTORS
Torque Ratings 13.8 to 112 inch-pounds per 100 psi (about 3 to 180 hp maximum)
For Pressures to 5000 psi
1500 to 3000 rpm
Catalogs FM-1, FM-2, FM-3-A

Dual-Purpose, Vane-Type PUMP/MOTOR
Ready for either pump or motor use without change
Shaft rotation in either direction
Four Sizes, 11 Models
Pumping Capacities: 3 to 82 gpm.
Motor Torque: 13 to 257 inch-pounds per 100 psi. Pressures to 2000 psi.
Bulletin P-5

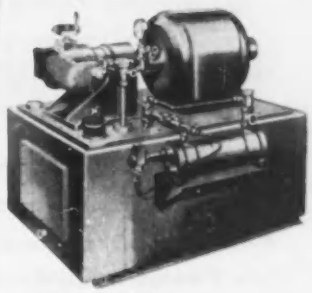


DIRECTIONAL CONTROLS
Manual, Mechanical, Electric or Pilot Control. ¼" to 2" Sizes
For Pressures to 5000 psi
Catalog VD-3



PRESSURE REDUCING VALVES
⅜" to 1½" Sizes
20 gpm to 65 gpm Capacities
For Pressures to 5000 psi
Catalog VPR-1

Multi-Range FLOW CONTROLS
Full-Scale Regulation—Adjustable for Varying Input
¼" to ¾" Sizes
For Pressures to 3000 psi
Catalogs VFC-1, VFC-2



PUMPING UNITS
Constant and Variable Volume
46 Models—2 to 35 gpm Capacities
For Pressures to 5000 psi
Bulletins PU-3-A, PU-4 and PU-5

PROVED IN USE

under industry's toughest operating conditions

Denison HydrOILic Pumps, Motors and Controls are noted for their combination of high efficiency and rugged dependability.

In addition to fine performance under continuous, heavy-duty use, Denison HydrOILic Equipment offers space-saving design that simplifies circuit layout, makes installation easier, and minimizes maintenance problems.

Because so many users verify the extra value built into Denison Pumps, Motors and Controls, we continue the challenge made so often before—*let comparison prove to you* why they are first choice for so many needs of every type. Write today for full details on Denison HydrOILic Equipment to meet your requirements.

Pilot-Operated, Solenoid-Controlled DIRECTIONAL VALVES
Eliminate Spool-Sticking
¾" to 1½" Sizes, For Pressures to 5000 psi
Catalogs VD-1-1 to VD-4-2

Hydraulically Balanced PRESSURE CONTROLS
¾" to 2" Sizes
For Pressures to 5000 psi
Catalogs VR-2-8 and VR-S-2

DENISON HydrOILic

PUMPS | MOTORS | CONTROLS | PRESSES

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The DENISON Engineering Company, 1157 Dublin Road, Columbus 16, Ohio

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Make Your Products Tough... Durable... Safe

The ability of malleable iron castings to stand up under impact and shock plus their resistance to atmospheric corrosion make them exceptionally valuable for products that must be rugged and durable.

Malleable's excellent machineability and ability to be cast close to final form greatly reduce machining costs. Take advantage of malleable's product-improving, cost cutting properties. Call a malleable foundry and go over your products with their engineers. Find out how their skill in designing and producing malleable iron castings makes better parts at lower cost.

This Extension Ladder Hook was hammered out of shape to show how tough malleable iron withstands severe impact and distortion without breaking, assuring safe operation of critical parts.

Send for "Malleable Iron Facts", useful information on malleable iron properties and uses. Just write to Malleable Founders Society, Union Commerce Building, Cleveland 14, Ohio.

Malleable FOUNDERS' SOCIETY

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Minimum weight, inertia, and backlash. A precision computer component. Designed for accurate resolution of angular position or velocity sums and differences. Hollow shaft design offers complete freedom of positioning of differential on shaft and facilitates installation-removal of differential from shaft without instrument disassembly. Shrink-on, safety-keyed side gears available to your specifications. Inertia: .0745 ounce-inch^2; maximum backlash: 10'; overall axial length: $1\frac{3}{16}$"; clearance radius: .520"; weight: $1\frac{1}{4}$ ounces; unit receives a $\frac{3}{16}$" diameter shaft. Precision ball bearings.

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A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

Unique design of new Howell Brake Motors gives you all these advantages:

- Short over-all length
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- Parts easily accessible for inspection or adjustment
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- External manual release; resumes automatic operation on power resumption
- Streamlined housing
- New wrap-around cover can be removed from side or back
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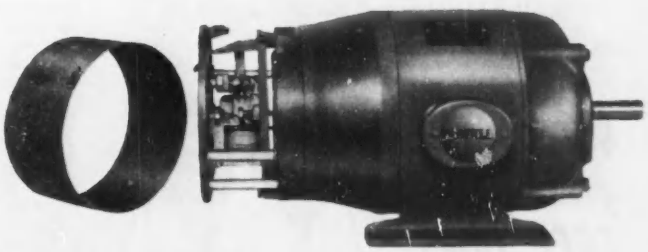
- No rivets to score cast-iron friction plates
- Constant torque regardless of duty, wear or adjustment
- Following ratings immediately available:
  - 10 pound/feet torque continuous duty
  - 15 pound/feet torque intermittent duty
  - 25 pound/feet torque continuous duty
  - 35 pound/feet torque intermittent duty

Howell is proud to accept undivided responsibility

for the performance and dependability of these new brake and motor combinations. The Howell representative in your area can give you complete engineering details, application assistance and prompt delivery. Call him today, or write direct to our plant.



New Howell Brake Motor with wrap-around cover removed to show arrangement and simplicity of parts, as well as accessibility for inspection or adjustment.

HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

MANUFACTURERS OF PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

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—don't try to make a standard motor stretch when the job calls for a Wesche Special Motor.

Most powering jobs can be solved satisfactorily with some kind of standard motor. Wesche is in business to solve the tougher problems that call for a specific combination of features. You tell us what the job requires and we design and build the motor that will do it—and go on doing it year after trouble-free year.

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The DESIGN and PERFORMANCE of SHAFT BEARINGS

THIS new book, includes the latest developments and procedures in bearing analysis and lubrication. It discusses, first, the general principles of bearing load analysis, introducing dimensional analysis in order to generalize the results of bearing load computations. It then takes up the principles and problems of hydrodynamic lubrication . . . discusses rolling contact bearings . . . and considers the many variables of importance in boundary lubrication. A final chapter describes a representative group of bearing test machines. Throughout the book, the external conditions imposed upon representative shaft bearings have been considered in detail and integrated with lubrication theory.

ANALYSIS and LUBRICATION of BEARINGS

By

Milton C. Shaw, *Dept. of Mech. Eng., M.I.T.*

and

E. Fred Macks, *Lewis Flight Propulsion Laboratory, N.A.C.A.*

618 pages, illustrated, $10.00

This new book's analysis of shaft bearings is divided, roughly, into external and internal phases. It considers the bearing in relation to its position in the mechanism, and studies the conditions imposed on the bearing by its surroundings. Attention is directed to the manner in which the bearing supports the applied load. Common practices used in the design of bearings are treated fully. The book discards those practices contrary to fundamental concepts, suggesting more logical criteria, and points the way to rational design procedures based upon sound principles and the results of controlled experiments.

A few outstanding features

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- **Covers new developments in the theory of boundary lubrication and dry friction**
- **Discusses new bearing materials and lubricants**
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- **Takes up such topics as high speed bearing stability, bearing erosion and limitations of present hydrodynamic bearing theory at high speeds**

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Best Protection

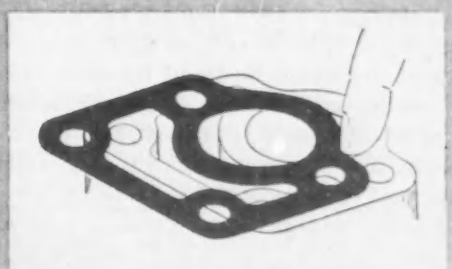
Against Leakage of LIQUIDS and GASES

Clad-Seal gaskets have a central stabilizing copper base cladded with lead on both sides. Overall thickness, held to close tolerance limits, permits accurate assembly spacing in pumps or similar applications.

The lead cladding provides ductile, inelastic sealing surfaces that do not cold-flow, extrude or separate from the strong supporting copper core.

The dimensional precision of this material together with its constant compressibility factor enables clamping force to be accurately predetermined and retaining screws accurately preloaded to limit fatigue stresses. Retained pressures may vary violently without corresponding fluctuations in retaining screw stresses.

The lead cladding does not deteriorate with age; is not affected by moisture or corrosion; does not shrink or swell and sheds no clogging particles or "whiskers".



Clad-Seals are easy and quick to install. Roughness or tool marks on joint surfaces do not cause leakage. No expensive precision machining is required. And Clad-Seals may be reused many times without loss of effectiveness.

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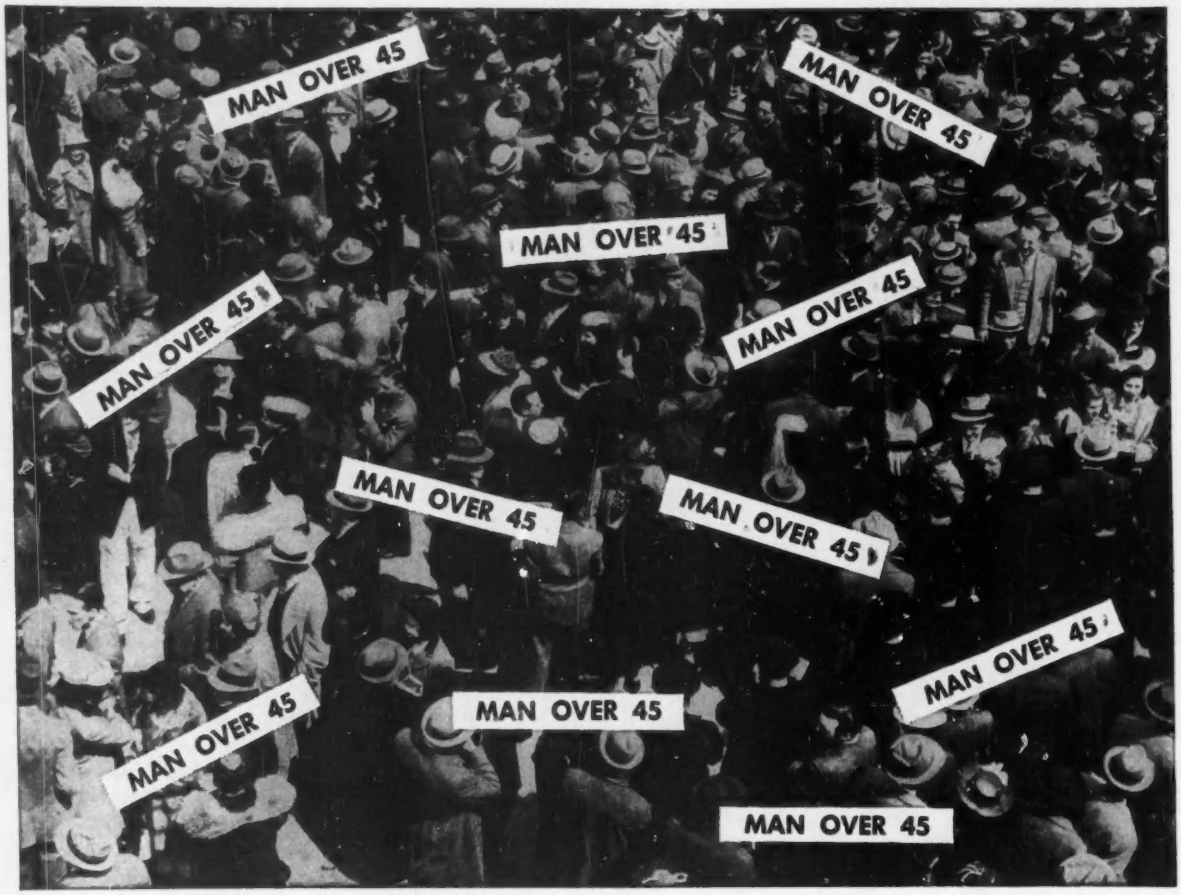


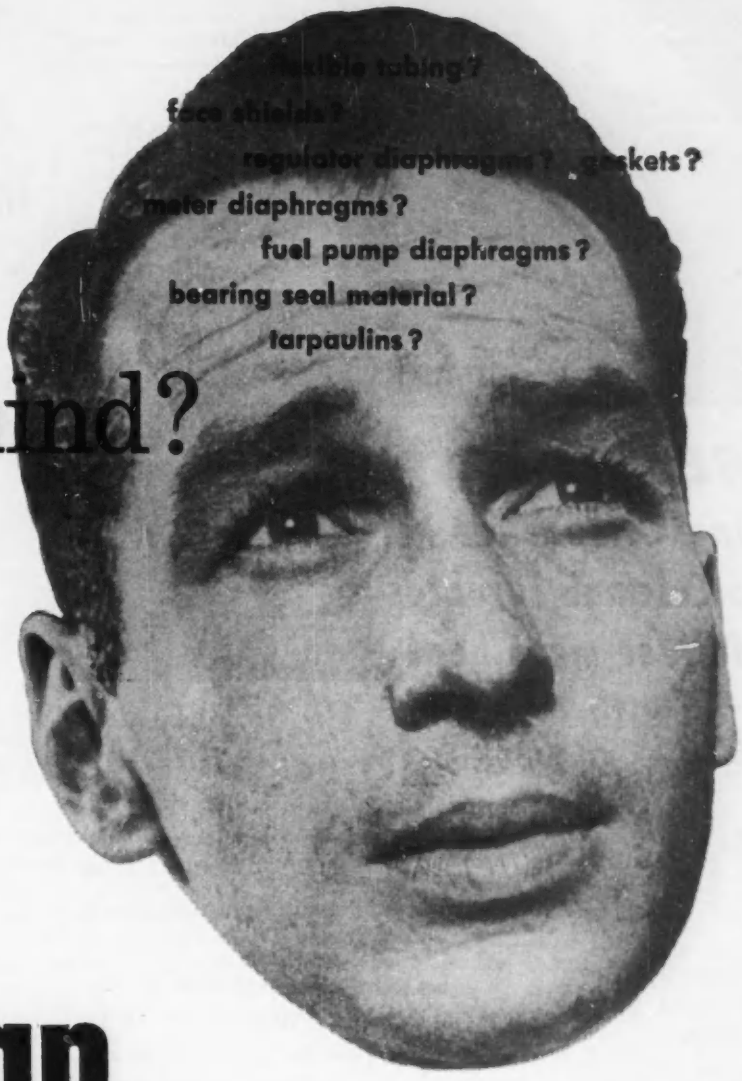
But why MEN over 45?

Our doctors still don't know *why*, but if you are a man over 45 you are six times as likely to develop lung cancer as a man of your age twenty years ago. They *do* know, however, that their chances of saving your life could be about *ten times* greater if they could only detect cancer long before you notice any symptom in yourself. (Only 1 in every 20 lung cancers is being cured today, largely because most cases progress too far before detected.) That's why we urge that you make a habit of having your chest X-rayed every six months, no matter how well you may *feel*. The alarming increase of lung cancer in men over 45 more than justifies such precautions. Far too many men die needlessly!

Our new film "The Warning Shadow" will tell you what every man should know about lung cancer. To see this film and to get life-saving facts about other forms of cancer, phone the American Cancer Society office nearest you or simply write to "Cancer"—in care of your local Post Office.

American Cancer Society

what's on your mind?



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can supply the right answer

You name it! If it's a synthetic coated fabric, Vulcan has it (or can develop it) to your most exacting specifications.

Vulcan has been making the world's finest industrial coated fabrics since 1925. In aviation, in the automotive field, in appliances, in the gas industry and communications, the list of consistent users of Vulcan precision-made fabrics reads like a "Who's Who" of American industry. And it includes the United States Government, as well.

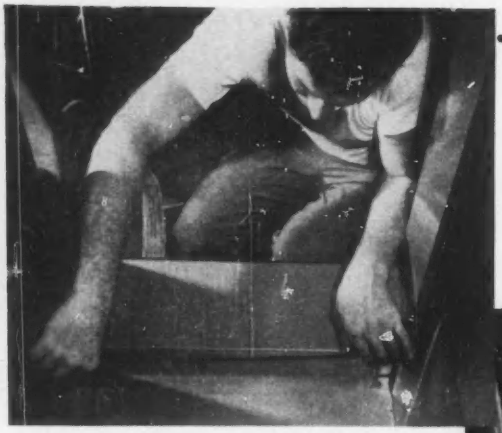
If you use industrial fabrics, or have a special fabric problem, drop Vulcan engineers a line. Once you switch to Vulcan, we predict that you'll never switch again.

Vulcan

For new catalog of Vulcan Industrial Coated Fabrics, or information on any coated fabric, write: Vulcan Rubber Products, Inc., 54 Worth Street, New York 13, New York.

VULCAN RUBBER PRODUCTS, INC., *54 Worth Street, New York 13, N. Y.*

Manufacturer of Vulcan-Duroflex products • A subsidiary of Reeves Brothers, Inc.

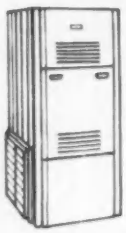


•• Elastic tape, extruded in beads, ribbons and tailored shapes, gains adhesion with aging.

Spotweld sealer on blower chute assembly remains soft and tight at high or low temperatures.

PRESSTITE

Sealing Compounds help Coleman Furnaces deliver more heat with less fuel!



To prevent costly casing leaks of heated air, which would reduce heating efficiency and increase fuel consumption, Coleman's famous Blend-Air furnaces are *sealed air-tight* with Presstite spotweld sealers and elastic tapes.

In order to transmit heated air at relatively high velocity through the ducts, static pressure must be built up in an air-tight furnace casing. Leaks would lower pressure, reduce air delivery and require extra fuel to make up the loss. By sealing the casing air-tight, Presstite sealing compounds play an important part in giving the Blend-Air owner more for his heating dollars.

Over 400 Presstite sealants protect against dust, dirt, air and water in thousands of sealing applications. Write today to learn how Presstite can meet your sealing needs, *whatever* they may be.

SEALANTS, ADHESIVES and COATINGS for

air conditioning, aircraft, appliances, aluminum windows, automobiles, breweries, bridges, cold storage, concrete curing, communications, dams and locks, excavation work, fuel tanks, greenhouses, highways, housing, railroad cars, refrigerators, reservoirs, sewers, storage tanks, trailers, trucks, and many other products and industries.

PRESSTITE SEALING COMPOUNDS

In Canada: Railway and Power Engineering Corp., Ltd.

PRESSTITE ENGINEERING COMPANY

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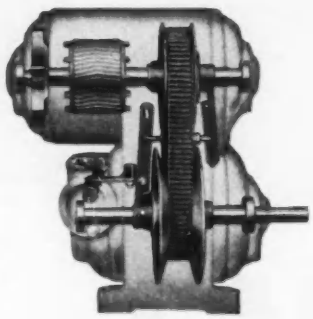
Speed-Trol Aids in Cutting Costs, Increasing Output

Sterling Speed-Trols are aiding in faster, more economical production of our patented Cherry Blind Rivet, reports Mr. Milo Ketchum, Chief Engineer of Cherry Rivet Company, Los Angeles. Speed-Trols were selected to drive our automatic upsetting machines because of their accurate speed selection, positive pulley adjustment, compactness, smooth, quiet operation. We have used Speed-Trols for over five years without repair costs.

STERLING SPEED-TROL



OUTSTANDING FEATURES:

Infinite speeds—positive speed regulation—fingertip control—large indicator—positive pulleys—no springs—belt tension in proportion to load—protected—streamlined—Herringbone Rotor—through ventilation—versatile mounting—NEMA dimensions—shock absorbing—quiet operation—rugged—compact—dependable—long life.

20-page illustrated catalog... Sterling Speed-Trol, Slo-Speed, Klosd and Klosd-Tite Electric Power Drives. Write for catalog No. 1-B-431

STERLING ELECTRIC MOTORS

Plants: New York City 51; Chicago, Ill.; Los Angeles 22; Hamilton, Canada; Santiago, Chile
Offices and distributors in all principal cities

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R. I. FLETCHER
Vice President and Comptroller
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"United States Savings Bonds are an ideal backlog investment for every employee, whatever his age or his earnings bracket. When bought automatically and conveniently through the Payroll Savings Plan they are almost 'painless' savings. I am one of many thousands of the employees of Newport News Shipbuilding and Dry Dock Company who regularly save every payday for investment in Savings Bonds through our Payroll Savings Plan. The security of the Nation rests upon the security of its individual citizens and all employees who practice the American habit of thrift are contributing to the national security as they provide for their own future."

Fortunately for America, industry and business recognize that "the security of the Nation rests upon the security of the individual."

More than 45,000 companies offer their employees the Payroll Savings Plan. In many of these companies more than 60% of the employees are Payroll Savers—in some, participation is 75%, 80%, and higher. But, in others participation is low—sometimes less than 25%.

Why does Company A have an employee participation of 75% while Company B—about the same size, in the same industry, with the same wage scales—has less than 25% of its employees enrolled in the Payroll Savings Plan? Is it because the employees of Company B are not concerned about their future, have no interest in personal security?

Men who head up industry-wide committees for the promotion of the Payroll Savings Plan . . . members of the Payroll Savings Advisory Committee . . . State Directors of the Treasury Department—any of these men can give you a quick answer:

"In every company with a good Payroll Savings Plan you'll find a 'top executive is heart and soul behind the plan—and everybody in the company, down to the last man in a subsidiary plant, knows it. When you find a company with a poor Payroll Plan the 'top man' will tell you, 'Yes, we have a Payroll Savings Plan. . . No, I don't know how many employees are enrolled or what the average monthly saving is. Mr. ———— takes care of that.'"

Currently, upwards of 8,000,000 men and women are enrolled in the Payroll Savings Plan. The 1954 goal—9,000,000—can be exceeded if you and other executives will take a personal interest in your company's Payroll Savings Plan. Any information and all the help you need to build a successful Plan can be obtained promptly from Savings Bond Division, U. S. Treasury Department, Washington Building, Washington, D. C.

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Wishing to work with congenial associates and modern equipment and facilities—
Seeking permanence of affiliation with a leading company and steady advancement—
Will find these in a career here at GENERAL MOTORS.

Positions now are open in ADVANCED DEVELOPMENT and PRODUCT DESIGN.
COMMERCIAL AUTOMOBILE RADIO
MILITARY RADIO, RADAR AND ELECTRONIC EQUIPMENT
ELECTRONIC COMPONENTS
INTRICATE MECHANISMS such as tuners, telemetering, mechanical linkages, controls, etc.
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Inquiries invited from recent and prospective graduates as well as experienced men with bachelors or advanced degrees in physics, electrical or mechanical engineering.
Salary increases based on merit and initiative.
Vacations with pay, complete insurance and retirement programs.
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All inquiries held in confidence and answered—WRITE or APPLY to

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Cessna

ENGINEERING OPPORTUNITIES

with world's leading producer of light commercial airplanes

for

- Design Engineers
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Send Resume to

CESSNA AIRCRAFT CO.
ENGINEERING PERSONNEL
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CHIEF ENGINEER

$30,000

Our company is a well-known and highly-regarded manufacturer of major appliances. Sales are in excess of $50,000,000 and we are located in a desirable mid-western city.

The man we are seeking will be a member of our top management team and will report directly to the President. He will be responsible for all research, design and development activities.

He should be an experienced Chief Engineer in such fields as major or table appliances, television, heating or similar products. Preferred age is 38 to 48 years.

Replies may be brief, should include home telephone and current position, and will be treated in strict confidence.

P-9700, Product Engineering, 330 W. 42 St., New York 36, N. Y.

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Prominent New England manufacturer needs Project Engineers capable of taking complete charge—from start to finish—of projects involving gears, speed reducers and other power transmission equipment. Send resume and salary requirements to

P-9899, Product Engineering
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If you are a qualified design engineer interested in development work on tire machinery and rubber processing equipment, we have an attractive position and would like to consider your application. We want a man with inventive turn of mind as the problems cover complex machinery to reduce manual operations. A real position with a real future. State age, experience and salary demand.

P-9801, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

Your inquiry will have special value . . .

if you mention this magazine, when writing advertisers. Naturally, the publisher will appreciate it . . . but, more important, it will identify you as one of the men the advertiser wants to reach with this message . . . and help to make possible enlarged future service to you as a reader.

ENGINEERS WHO WANT

to start on an interesting and rewarding future

A leading company in its field is looking for mechanical and electrical engineering graduates who want to build their future as vibration specialists. Work is available on electrical and electronic devices, including servo-mechanisms, used in the field of vibration testing and control. Men are wanted who are capable of handling significant programs as project engineers.

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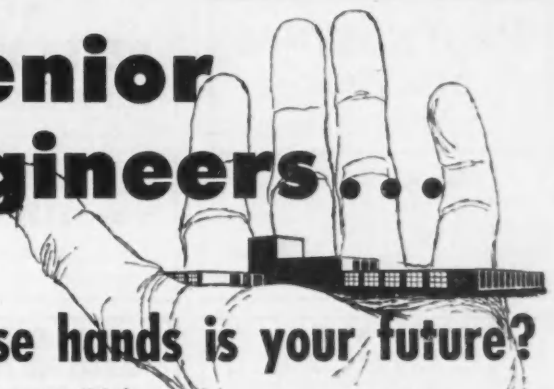
Write, giving educational details, experience and salary, prior to appointment to discuss the openings.

P-9826, Product Engineering
330 W. 42 St., New York 36, N. Y.

senior engineers . . .



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MELPAR has an unparalleled opportunity to offer you—rapid progress and sound future—varied project assignments under the guidance of nationally known engineers. In addition to numerous and challenging projects—both military and industrial—Melpar is Research Headquarters for the Westinghouse Air Brake Company and its affiliates.

If you can qualify—high achievement, financial security and gracious living await you here! Melpar is located in the beautiful Virginia suburbs, just a few minutes from the Nation's Capital. A grand place to build a grand future! Let's discuss it all in detail.

THREE TO FIVE YEARS EXPERIENCE IS DESIRED IN ONE OR MORE OF THESE OR ALLIED FIELDS

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THE RESEARCH LABORATORY OF WESTINGHOUSE AIR BRAKE CO. AND ITS SUBSIDIARIES

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For design of special medium weight automatic equipment. Will be called upon to experiment with and recommend improvements to existing equipment as well as design of new equipment. Degree in mechanical engineering desirable. Should have a minimum of five years of design experience. Location: Chicago. Compensation dependent upon experience and ability.

Position is not dependent on defense contracts and is permanent and offers good working conditions with excellent company benefits. Replies will be treated confidential and arrangements will be made to interview selected applicants.

Submit complete resume stating experience, education, salary required and date available.

P-9721, Product Engineering
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WANTED

Design & Process Development ENGINEERS

Design and process development engineers wanted to work on developing and improving glass manufacturing processes for a leading glass company located in Ohio. Openings for mechanical, chemical, ceramic, and electrical engineers. Duties will involve carrying new processes through development into manufacturing.

Salary commensurate with training and experience.

Reply should include resume of training and education and should state salary requirements.

P-9711, Product Engineering
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at Teletype Corporation

★ Professional men with experience in the design of intricate mechanisms are wanted by Teletype Corporation as permanent additions to our technical staff.

You will be responsible for the design, layout, and engineering of new products from inception to release for manufacture. Every available modern facility required for your work will be placed at your disposal.

Practically every industry has been served by this organization in the past 25 years. Our equipment, which is in the communications field, is now being applied to various business operations. Therefore, the development of new applications offers continuous challenge.

TELETYPE CORPORATION
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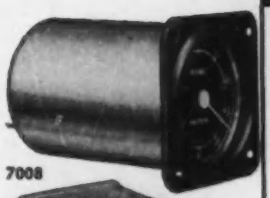
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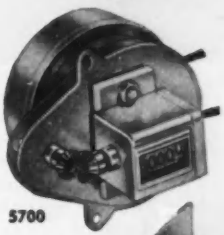
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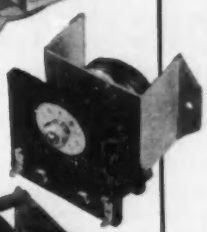
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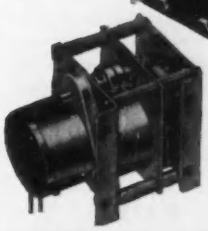
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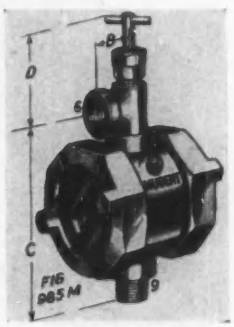

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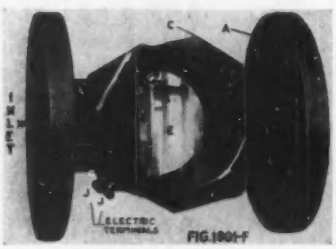

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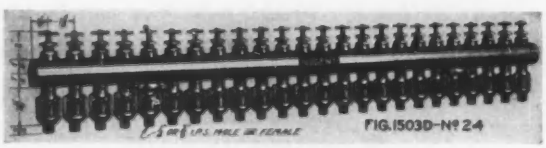

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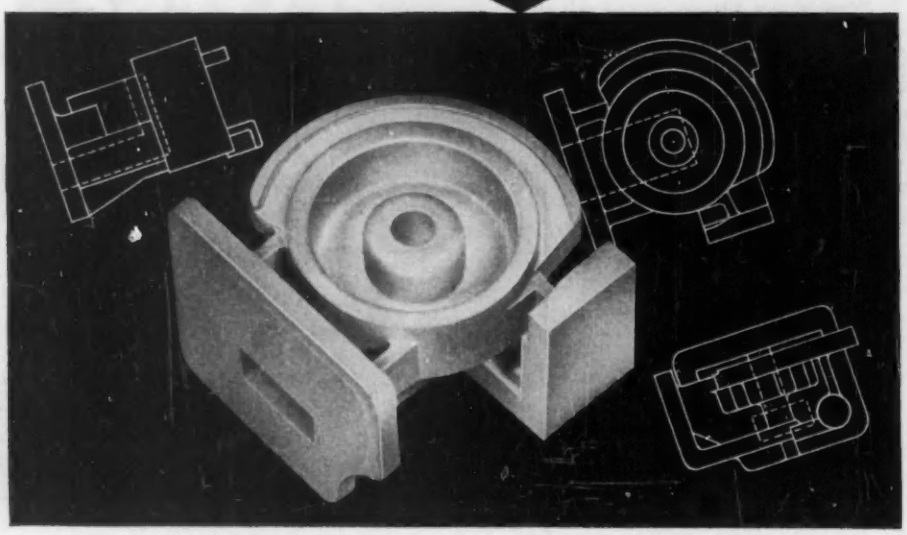

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